RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysore Road

Bengaluru – 560 059

Bachelor of Engineering (B.E.)
Scheme and Syllabus of VII & VIII Semesters

2016 SCHEME

TELECOMMUNICATION ENGINEERING

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

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2016 SCHEME

DEPARTMENT OF
TELECOMMUNICATION ENGINEERING

Department Vision

Imparting quality education in Electronics and Telecommunication Engineering through focus on fundamentals, research and innovation for sustainable development

Department Mission

- Provide comprehensive education that prepares students to contribute effectively to the profession and society in the field of Telecommunication.
- Create state-of-the–art infrastructure to integrate a culture of research with a focus on Telecommunication Engineering Education
- Encourage students to be innovators to meet local and global needs with ethical practice
- Create an environment for faculty to carry out research and contribute in their field of specialization, leading to Center of Excellence with focus on affordable innovation.
- Establish a strong and wide base linkage with industries, R&D organization and academic Institutions.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO	Description
PEO1	Acquire appropriate knowledge of the fundamentals of basic sciences, mathematics, engineering sciences, Electronics & Telecommunication engineering so as to adapt to rapidly changing technology
PEO2	Think critically to analyze, evaluate, design and solve complex technical and managerial problems through research and innovation.
PEO3	Function and communicate effectively demonstrating team spirit, ethics, respectful and professional behavior.
PEO4	To face challenges through lifelong learning for global acceptance.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	Description
PSO1	Analyze, design and implement emerging Telecommunications systems using devices, sub-systems, propagation models, networking of Wireless and Wire line communication systems.
PSO2	Exhibit Technical skills necessary to choose careers in the design, installation, testing, management and operation of Telecommunication systems.

Lead Society: Institute of Electrical and Electronics Engineers (IEEE)

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics

INDEX

VII Semester			
Sl. No.	**Course Code**	**Course Title**	**Page No.**
1.	16TE71	Wireless and Mobile Communication	1
2.	16TE72	Optical Fiber Communication	3
3.	16TE73P	Minor Project	5
GROUP F: PROFESSIONAL CORE ELECTIVES			
1.	16TE7F1	ASIC Design	7
2.	16TE7F2	Digital Image Processing	9
3.	16TE7F3	Satellite Communication	11
4.	16TE7F4	Real Time Embedded systems	13
GROUP G: PROFESSIONAL CORE ELECTIVES			
5.	16TE7G1	Cellular Mobile Network	15
6.	16TE7G2	DSP Applications	17
7.	16TE7G3	AdHoc Networks	19
8.	16TE7G4	Internet of Things (IoT)	21

GROUP H: GLOBAL ELECTIVES				
Sl. No.	**Course Code**	**Host Dept**	**Course Title**	**Page No.**
1.	16G7H01	BT	Nanotechnology	23
2.	16G7H02	CH	Industrial Safety and Risk Management	25
3.	16G7H03	CV	Intelligent Transportation Systems	27
4.	16G7H04	CS	Intelligent Systems	29
5.	16G7H05	EC	Image Processing & Machine Learning	31
6.	16G7H06	EE	Design of Renewable Energy Systems	33
7.	16G7H07	IM	Systems Engineering	35
8.	16G7H08	EI	MEMS and Applications	37
9.	16G7H9	IS	Introduction to Internet of Things	39
10.	16G7H10	ME	Industry 4.0 – Smart Manufacturing for the Future	41
11.	16G7H11	TE	Space Technology and Applications	43
12.	16G7H12	MA	Advanced linear Algebra	45
13.	16G7H13	PY	Thin Film Nanotechnology	47
14.	16G7H14	CY	Engineering Materials for Advanced Technology	49
15.	16G7H15	HSS	Applied Psychology for Engineers	51
16.	16G7H16	HSS	Foundational Course on Entrepreneurship	53
17.	16G7H17	AS	Unmanned Aerial Vehicles	57

VIII Semester			
Sl. No.	**Course Code**	**Course Title**	**Page No.**
1.	16TE81	Major Project	59
2.	16TE82	Technical Seminar	62
3.	16HS83	Innovation and Social Skills	63

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TELECOMMUNICATION ENGINEERING

SEVENTH SEMESTER CREDIT SCHEME								
Sl. No	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**				**Total Credits**
				Lecture	**Tutorial**	**Practical**	**SS**	
1	16TE71	Wireless and Mobile Communication	TE	4	0	1	0	**5**
2	16TE72	Optical Fiber Communication	TE	4	0	1	0	**5**
3	16TE73P	Minor Project	TE	0	0	3	0	**3**
4	16TE7FX	Elective F	TE	4	0	0	0	**4**
5	16TE7GX	Elective G	TE	4	0	0	0	**4**
6	16GH7XX	Elective H (GE)*	TE	3	0	0	0	**3**
Total No. of Credits				**19**	**0**	**5**	**0**	**24**
No. of Hrs.				**19**	**0**	**10**	**0**	

*Students should take other department Global Elective courses

EIGTH SEMESTER CREDIT SCHEME								
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**				**Total Credits**
				Lecture	**Tutorial**	**Practical**	**SS**	
1.	16TE81	Major Project	TE	0	0	16	0	**16**
2.	16TE82	Technical Seminar	TE	0	0	2	0	**2**
3.	16HS83	Innovation and Social Skills	HSS	0	0	2	0	**2**
Total No. of Credits				**0**	**0**	**20**	**0**	**20**
No. of Hrs.				**0**	**0**	**40**	**0**	**40**

VII Semester		
GROUP F: PROFESSIONAL CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	16TE7F1	ASIC Design
2.	16TE7F2	Digital Image Processing
3.	16TE7F3	Satellite Communication
4.	16TE7F4	Real Time Embedded systems
VII Semester		
GROUP G: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	16TE7G1	Cellular Mobile Network
2.	16TE7G2	DSP Applications
3.	16TE7G3	AdHoc Networks
4.	16TE7G4	Internet of Things (IoT)

VII Semester			
GROUP H: GLOBAL ELECTIVES			
Sl. No.	**Host Dept**	**Course Code**	**Course Title**
1.	BT	16G7H01	Nanotechnology
2.	CH	16G7H02	Industrial Safety and Risk Management
3.	CV	16G7H03	Intelligent Transport System
4.	CS	16G7H04	Intelligent Systems
5.	EC	16G7H05	Image Processing and Machine Learning
6.	EE	16G7H06	Design of Renewable Energy Systems
7.	IM	16G7H07	Systems Engineering
8.	EI	16G7H08	MEMS and Applications
9.	IS	16G7H9	Introduction to Internet of Things
10.	ME	16G7H10	Industry 4.0 – Smart Manufacturing for The Future
11.	TE	16G7H11	Space Technology and Applications
12.	MA	16G7H12	Advanced linear Algebra
13.	PY	16G7H13	Thin Film Nanotechnology
14.	CY	16G7H14	Engineering Materials for Advanced Technology
15.	HSS	16G7H15	Applied Psychology for Engineers
16.	HSS	16G7H16	Foundational Course on Entrepreneurship
17.	AS	16G7H17	Unmanned Aerial Vehicles

Semester: VII						
WIRELESS AND MOBILE COMMUNICATION (Theory & Practice)						
Course Code	**:**	**16TE71**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P:S	**:**	**4:0:1:0**		**SEE**	**:**	**100+50 Marks**
Hrs/week	**:**	**45L**		**SEE Duration**	**:**	**3.00+3.00 Hours**

Course Learning Objectives: The students will be able to

1	Describe cellular concepts, fading, Wireless Network and standards.
2	Analyze the concepts of propagation model and differentiate different Wireless networks.
3	Demonstrate path loss models and wireless networks for various applications.
4	Compare the concepts of WBAN, WPAN, WLAN and WMAN standards and their Architecture.

UNIT-I	**09 Hrs**
Cellular concept: Introduction Frequency reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Improving coverage and capacity in cellular systems-Cell splitting & Cell Sectoring.	
UNIT-II	**10 Hrs**
Propagation: Introduction to radio wave Propagation, Free Space Propagation Model, Reflection, Diffraction, Scattering. Outdoor Propagation models: Okumura, Hata, Indoor Propagation models. **Small scale fading:** Small scale fading Multipath Propagation, Small scale Multipath measurements, Parameters of Mobile Multipath Channels, Types of Small scale fading.	
UNIT-III	**10 Hrs**
Basics of Wireless Networks: Wireless Network architecture, Wireless Communication Problems, Wireless Network reference model, Wireless Networking issues, Wireless Networking standards. **Wireless Body area Network:** Network Architecture, Network Components, Network Protocols, WBAN Applications.	
UNIT-IV	**08 Hrs**
Wireless Personal Area Networks: WPAN and its Network architecture, WPAN components, WPAN technologies and protocols: IEEE 802.15.1, IEEE 802.15.2, IEEE 802.15.3, IEEE 802.15.4, WPAN Applications.	
UNIT-V	**08 Hrs**
Wireless local Area networks: Network components, Design requirements of WLAN, Network Architecture, WLAN Standards. **Wireless Metropolitan Area Networks:** IEEE 802.16 standards, advantages, IEEE 802.11 Vs IEEE 802.16, WMAN Network architecture, WMAN Applications.	

Laboratory Experiments
1. Simulation of Okumura path loss model using MATLab simulation.
2. Realization of the HATA model using MATLab.
3. Realization of Indoor propagation model using MATLab.
4. Design and simulation of CDMA using MATLab.
5. Demonstrate operation of BPSK, QPSK & QAM modulation using **VSA/system vieu.**
6. Configure a WiMax N/W, UMTS N/W, wireless sensor networks, 2G network, VoIP using **Qualnet**.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain cellular concepts, fading, wireless networks and Wireless standards.
CO2	Analyze path loss models, fading types and also distinguish wireless networks and Wireless standards.
CO3	Apply the WBAN, WPAN, WLAN and WMAN standards for a given network application
CO4	Evaluate the performance of various wireless network standards.
Reference Books	
1	Wireless Communications Principles and practice, Theodore S Rappaport, 2nd Edition, Pearson, ISBN 97881-317-3186-4.
2	Wireless and Mobile Networks Concepts and Protocols, Dr. Sunil Kumar S Manvi, 2010 Edition, 2010, Willey India Pvt. Ltd., ISBN: 978-81-265-2069-5.
3	Wireless Communication, Upena Dalal, 1st Edition, 2009, Oxford higher Education, ISBN-13:978-0-19-806066-6.

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Theory – 100 Marks

CIE is executed by way of Quizzes (Q), Tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. **Total marks for the laboratory is 50**.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory – 100 Marks

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	---	---	---	---	---	---	---	2	---	1
CO2	2	3	3	---	---	2	1	---	---	---	---	2
CO3	---	2	---	3	2	---	---	---	---	3	---	3
CO4	---	3	2	---	2	1	---	---	2	2	---	3

High-3: Medium-2: Low-1

Semester: VII						
OPTICAL FIBRE COMMUNICATION (Theory & Practice)						
Course Code	**:**	**16TE72**		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P:S	**:**	**4:0:1:0**		**SEE**	**:**	**100+50 Marks**
Hrs/week	**:**	**45L**		**SEE Duration**	**:**	**3.00+3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the overview and generations of Optical communication & Networks.
2	Design analog and digital link and their characterization
3	Analyze WDM concepts, components and their selection
4	Analyze network standards such as SONET/SDH & topologies.

UNIT-I	**09 Hrs**
Overview of Optical Fiber Communications: Motivations for Light wave Communications, Optical Spectral Bands, Fundamental Data Communication Concepts, Network Information Rates, Key elements of Optical Fiber Systems. **Optical Fibers: Structures, Wave guiding:** The Nature of Light, Basic Optical Laws and Definitions, Optical Fiber Modes and Configurations, Single-mode Fibers, Graded-index Fiber Structure**.**	
UNIT-II	**09 Hrs**
Signal Degradation in Optical Fibers: Attenuation, Signal Distortion in Fibers, Characteristics of Single-Mode Fibers. **Optical Sources:** Light-Emitting Diodes (LEDs), Laser Diodes, Line Coding.	
UNIT-III	**09 Hrs**
Power Launching and Coupling: Source-to-Fiber Power Launching, Lensing Schemes for Coupling Improvement, Fiber-to-Fiber Joints, LED Coupling to Single-Mode Fibers, Fiber Splicing. **Photo detectors:** Physical Principles of Photodiodes, Photo detector Noise, Detector Response Time, Avalanche Multiplication Noise, Structures for InGaAs APDs.	
UNIT-IV	**09 Hrs**
Optical Receiver Operation: Fundamental Receiver Operation, Digital Receiver Performance, Eye Diagrams, Coherent Detection, Burst-Mode Receivers, Analog Receivers**.** **Analog Links:** Overview of Analog Links, Carrier-to-Noise Ratio, Multichannel Transmission Techniques.	
UNIT-V	**09 Hrs**
Digital Links: Point-to-Point Links, Power Penalties. **WDM Concepts:** Overview of WDM**:** Operational principles of WDM, WDM Standards, SONET/SDH: Transmission Formats & Speeds, Rings, Networks.	

Laboratory Experiments
• Attenuation, bending losses and Numerical Aperture of optical fiber. • Characterization of analog link, digital link and BER measurement. • Realization of voice link and TDM. • Simulation of WDM system using Optisystem. • Link power budget analysis using Optisystem.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the characterization of fibers, optical sources, detectors & their selection
CO2	Apply the design methodology for analog & digital optical links
CO3	Analyze the concepts of WDM in optical networks with standards.
CO4	Evaluate the selection of network topology and network standards.

Reference Books	
1	Optical Fiber Communication, Gerd Keiser, 5th Edition, 2009, Tata MGH, ISBN: 0-07-064810-7.
2	Optical Fiber Communication, John M Senior PHI, 2nd Edition, 2009, ISBN-0324359810.
3	Fiber Optics Communication Systems, G.P. Agarwal, 3rd Edition, 2004, John Wiley New York, ISBN: 9-8141-2660-8.

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Theory – 100 Marks

CIE is executed by way of Quizzes (Q), Tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Laboratory- 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks**. Total marks for the laboratory is 50**.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory – 100 Marks

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	2	---	---	2	1	2	---	1
CO2	3	3	2	1	2	---	---	2	1	2	---	1
CO3	3	3	3	2	2	---	---	2	1	2	---	2
CO4	3	3	3	2	3	---	---	2	1	2	---	2

High-3: Medium-2: Low-1

Semester: VII						
MINOR PROJECT						
Course Code	**:**	**16TE73P**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**3:0:0:0**		**SEE**	**:**	**100 Marks**
Hrs/week	**:**	**06**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Create interest in innovative developments and preferably interdisciplinary field.
2	Work independently, analyze, evaluate and solve the given problem.
3	Inculcate the skills for good presentation and improve the technical report writing skills.
4	Recognize the need for planning, preparation, management and financial budgeting.
5	Acquire collaborative skills through working in a team to achieve common goals.

Mini Project Guidelines:

1. Each project group will have two to four students, they can form their groups amongst their class.
2. Each group has to select a current topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Guides will be allotted by the department based on the topic chosen.
4. The project should result in system/module which can be demonstrated, using the available resources in the college.
5. The CIE evaluation will be done by the committee constituted by the department. The committee shall consist of respective guide & two senior faculty members as examiners. The evaluation will be done for each student separately.
6. The final copy of the report should be submitted after incorporation of any modifications suggested by the evaluation committee.

Guidelines for Evaluation:

CIE Assessment:

Evaluation will be carried out in three phases:

Phase	Activity	Weightage
I	Synopsis submission, approval of the selected topic, formulation of objectives.	20%
II	Mid-term evaluation to review the progress of work and documentation.	30%
III	Submission of report, Final presentation and demonstration.	50%

The following are the weightages given for the various stages of the project:

1. Selection of the topic and formulation of objectives: 10%
2. Design and Development of Project methodology: 30%
3. Execution of Project: 30%
4. Presentation, Demonstration and Discussion: 20%
5. Report Writing:10%

SEE Assessment:

The following are the weightages given during SEE Examination:

1. Written presentation of synopsis:10%
2. Presentation/Demonstration of the project: 30%
3. Methodology and Discussion: 30%
4. Technical Report: 10%
5. Viva Voce: 20%

Course Outcomes of Mini Project:	
1	Define Specifications, Conceptualize, Design and implement a project.
2	Communicate the work carried out as a technical report and orally.
3	Work in a team and contribute to team work.
4	Indulge in self-learning and be motivated for life-long learning.

Semester: VII						
ASIC DESIGN **(GROUP F: PROFESSIONAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**16 TE7F1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Explain ASIC methodologies and programmable logic cells to implement a function.
2	Analyze back-end physical design flow, including partitioning, floor-planning, placement, and routing.
3	Design using CAD algorithms and to apply these concepts in ASIC design.
4	Evaluate various design alternatives and make comparative study.

UNIT-I	**09 Hrs**
Introduction to ASICs, Full custom, Semi-custom and Programmable ASICs, ASIC Design flow, ASIC cell libraries. **Data Logic Cells:** Data Path Elements, Adders: RCA, Carry bypass, Carry save, Carry select, Conditional sum adder.	
UNIT-II	**09 Hrs**
Multiplier (Booth encoding), Data path Operators, I/O cells. **ASIC Library Design:** Logical effort: Predicting Delay, Logical area and logical efficiency, Logical paths, Multi stage cells, Optimum delay and number of stages.	
UNIT-III	**09 Hrs**
Programmable ASIC Logic Cells: MUX as Boolean function generators, Actel ACT: ACT 1, ACT 2 and ACT 3 Logic Modules, Xilinx LCA: XC3000 CLB, Altera FLEX and MAX. **Programmable ASIC I/O Cells:** Xilinx and Altera I/O Block. Introduction to Logic Synthesis and simulations. Low-level design entry: Schematic entry for ASICs, Hierarchical design, Net-list screener.	
UNIT-IV	**09 Hrs**
ASIC Construction-I: Physical Design, CAD Tools. **Partitioning:** Goals and objectives, Constructive Partitioning, Iterative Partitioning Improvement: KL, FM and Look Ahead algorithms. **Floor planning:** Goals and objectives, Floor planning tools, Channel definition, I/O, Power and Clock planning.	
UNIT-V	**09 Hrs**
ASIC Construction-II: Placement: Goals and Objectives, Min-cut Placement algorithm, Iterative Placement Improvement, Physical Design Flow. **Global Routing:** Goals and objectives, Global Routing Methods, Back-annotation **Detailed Routing:** Goals and objectives, Measurement of Channel Density, Left-Edge and Area-Routing Algorithms, Circuit extraction and Design checks.	

Course Outcomes: After completing the course, the students will be able to

CO1	Describe the concepts of ASIC design methodology, data path elements, logical effort and FPGA architectures.
CO2	Analyze the design of FPGAs and ASICs suitable for specific tasks, perform design entry and explain the physical design flow
CO3	Design data path elements for ASIC cell libraries and compute optimum path delay.
CO4	Develop CAD algorithms for system partition, floorplan, placement and routing.

Reference Books	
1	Application Specific Integrated Circuits, Michael John Sebastian Smith, 1st Edition, 1997, Addison-Wesley Professional, ISBN: 0-201-50022-1.
2	CMOS VLSI Design: A Circuits and Systems Perspective, Neil H.E. Weste, David Harris, and Ayan Banerjee, 3rd Edition, 2006, Pearson education, ISBN: 108177585681.
3	VLSI Design: A Practical Guide for FPGA and ASIC Implementations, Vikram Arkalgud Chandrasetty, 2011, Springer, ISBN: 978-1-4614-1119-2.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Assignment/Presentation/Project 10.
Total CIE is 30(Q) +50(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	---	---	2	---	---	---	---	---	---	---
CO2	1	1	1	---	2	---	---	---	---	---	---	1
CO3	2	2	1	---	2	---	---	---	---	---	---	1
CO4	1	1	1	1	2	---	---	---	---	---	---	1

High-3: Medium-2: Low-1

Semester: VII						
DIGITAL IMAGE PROCESSING (GROUP F: PROFESSIONAL ELECTIVE) (Theory)						
Course Code	**:**	**16TE7F2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	List and understand various processes and steps employed in image processing.
2	Illustrate different transforms used in image operations.
3	Analyze image enhancement and restoration processes and techniques.
4	Apply image processing in real time applications.

UNIT-I	**09 Hrs**
Introduction: What is Digital Image Processing, Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in digital Image Processing, Components of an Image Processing System. **Digital Image Fundamentals:** Elements of Visual Perception, A Simple Image Formation Model, Basic Concepts in Sampling and Quantization, Representing Digital Images, Spatial and Gray-level Resolution, Zooming and Shrinking Digital Images, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations.	
UNIT-II	**09 Hrs**
Image Transforms: Two-dimensional orthogonal & unitary transforms, Properties of unitary transforms, two-dimensional discrete Fourier transform, discrete cosine transform, sine transform, Hadamard transform, Haar transform, Slant transform, KL transform.	
UNIT-III	**09 Hrs**
Image Enhancement in Spatial domain: Some Basic Gray Level Transformations, Histogram Processing, Enhancement using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters. **Image Enhancement in the Frequency Domain:** Smoothing Frequency-Domain Filters, Sharpening Frequency Domain Filters, Homomorphic Filtering.	
UNIT-IV	**09 Hrs**
Image Restoration: A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering. Color Fundamentals, Color Models, Pseudo-color Image Processing, Basics of Full-Color Image Processing.	
UNIT-V	**09 Hrs**
Morphological Image Processing: Preliminaries, Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms. **Image Segmentation:** Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand digital image processing fundamentals and its applications.
CO2	Apply image processing techniques in both spatial and frequency domains.
CO3	Analyze and apply different operations on an image for various applications.
CO4	Apply and justify the use of image processing in modern multimedia communication, society and Technology.

Reference Books	
1	Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, Pearson Education, 2nd Edition, 2001, ISBN-13: 978-0131687288.
2	Fundamentals of Digital Image Processing, Anil K. Jain, Pearson Education / PHI, 2001, ISBN: 9780133361650.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +50(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	1	1	---	---	---	1	---	---	---
CO2	3	2	2	1	1	---	---	---	1	---	---	---
CO3	3	2	2	1	1	---	---	---	1	---	---	---
CO4	3	3	2	2	1	---	---	---	1	---	---	---

High-3: Medium-2: Low-1

Semester: VII						
SATELLITE COMMUNICATIONS (GROUP F: PROFESSIONAL ELECTIVE) (Theory)						
Course Code	**:**	**16TE7F3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**4:0:0:0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Classify satellites, orbital parameters, Launch vehicles and learn basic principles of satellite communication.
2	Explain the various subsystems of Satellite and Earth Station.
3	Explain and differentiate multiple access techniques.
4	Analyze and design satellite links.

UNIT-I	**09 Hrs**
Introduction to Satellites and their Applications: Ever-expanding application spectrum, What is a Satellite? History of the Evolution of Satellites, Evolution of Launch Vehicles, Future Trends. **Satellite Orbits and Trajectories :**Definition of an Orbit and a Trajectory, Orbiting Satellites – Basic Principles, Orbital Parameters, Injection Velocity and Resulting Satellite Trajectories, Types of Satellite Orbits.	
UNIT-II	**09 Hrs**
Satellite Launch and In-orbit Operations: Acquiring the Desired Orbit, Launch Sequence, Orbital Perturbations, Satellite Stabilization, Orbital Effects on Satellite's Performance, Look Angles of a Satellite, Earth Coverage and Ground Tracks.	
UNIT-III	**09 Hrs**
Satellite Hardware: Satellite Subsystems, Mechanical Structure, Propulsion Subsystem, Thermal Control Subsystem, Power Supply Subsystem, Attitude and Orbit Control, Tracking, Telemetry and Command Subsystem, Payload, Antenna Subsystem, Space Qualification and Equipment Reliability. **Earth Station**: Types of Earth Station, Earth Station Architecture, Earth Station Design Considerations, Earth Station Testing, Earth Station Hardware, Satellite Tracking.	
UNIT-IV	**09 Hrs**
Satellite Link Design Fundamentals : Transmission Equation, Satellite link parameters, Frequency Considerations, Propagation Considerations, Techniques to Counter Propagation Effects, Noise Considerations, Interference-related Problems, Antenna Gain-to-Noise Temperature (G/T) Ratio, Link Design.	
UNIT-V	**09 Hrs**
Multiple Access Techniques: Introduction to Frequency Division Multiple Assignment and Access, FDMA - Single Channel Per Carrier (SCPC) Systems, Multiple Channels Per Carrier (MCPC) Systems, Space Domain Multiple Access (SDMA). Concepts of Time Division Multiple Access (TDMA) -TDMA Frame Structure, TDMA Burst Structure, Computing Unique Word Detection Probability, TDMA Frame Efficiency, Control and Coordination of Traffic, Frame Acquisition and Synchronization. Code Division Multiple Access (CDMA), concept of CDMA/SS and CDMA/FH.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain various Orbital Parameters, Satellite Link Parameters and Propagation considerations.
CO2	Analyze Orbital Mechanics, TT&C and other design issues.
CO3	Apply multiple Access Techniques in Satellite Communication.
CO4	Design basic satellite link system for Uplink and Downlink and evaluate C/N overall for the link.

Reference Books	
1	Satellite Technology - Principles and Applications, Anil K Maini, Varsha Agarwal, 2nd Edition, 2011, John Wiley and Sons, ISBN: 9780470660249.
2	Satellite Communication Concepts and applications, K N Raja Rao, 2013, 2nd Edition, PHI, ISBN: 978-81-203-4725-0.
3	Satellite Communication, Timothy Pratt, Charles W. Bostian, 2nd Edition, 2012, John Wiley & Sons, ISBN: 9814126845.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +50(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	---	---	----	---	---	---	---	---	---	---	---
CO2	3	2	---	2	---	---	---	---	---	---	---	---
CO3	3	---	---	---	---	---	---	---	---	---	---	---
CO4	3	3	3	---	---	---	---	---	---	---	---	2

High-3: Medium-2: Low-1

Semester: VII						
REAL-TIME EMBEDDED SYSTEMS (GROUP F: PROFESSIONAL ELECTIVE) (Theory)						
Course Code	**:**	**16TE7F4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P :S	**:**	**4 : 0 : 0 : 0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Describe the concepts and system components of embedded system.
2	Interpret embedded system, general computing systems and the issues that arise in
3	Illustrate the Design and Development of the Program model.
4	Analyze the concepts of hardware debugging
5	Evaluate and apply the concepts of RTOS, IPC‘s and Semaphores in real time embedded system

UNIT-I	**09 Hrs**
Embedded System: Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Onboard Communication Interface, External Communication Interface, Embedded Firmware, Other System Components-Reset Circuit, Brown out Protection Circuit, Oscillator Unit, Real Time Clock, Watch Dog Timer. **Embedded System-Application and Domain Specific:** Washing Machine-Application Specific Case Study, Automotive-Domain Specific Case Study, Digital Camera, Smart Card.	
UNIT-II	**09 Hrs**
Characteristics and Quality Attributes of Embedded Systems: Characteristics of Embedded system, Quality Attributes of an Embedded System, Non-Operational Quality attributes. **Hardware Software Co-Design and Program Modelling:** Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language, Hardware Software Trade-offs.	
UNIT-III	**09 Hrs**
Embedded Firmware Design and Development: Embedded Firmware Design Approaches Embedded Firmware Development Languages. **The Embedded System Development Environment:** The Integrated Development Environment (IDE), Disassembler/ Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan.	
UNIT-IV	**09 Hrs**
RTOS -Tasks, Semaphores, Message Queues : Introduction, defining an RTOS, the scheduler, objects, services, key characteristics of an RTOS ,defining a task, task states and scheduling, types of task operations, typical task structure, synchronization, communication and concurrency, defining Semaphore, typical Semaphore operations, typical Semaphore use.	
UNIT-V	**09 Hrs**
IPC and Synchronization: Defining message queues, message queues states, message queues content, pipes, event registers, signals, condition variables. Synchronization, Communication, Resource Synchronization, Critical Section revisited.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify the concepts of system components to assemble small embedded systems.
CO2	Analyze the synchronization of system components in embedded systems.
CO3	Apply firmware Design and development tools for designing Embedded System.
CO4	Apply the key concepts of Real-Time Operating Systems in Embedded system design

Reference Books	
1	Introduction to Embedded Systems, Shibu K V, 2009, Tata McGraw Hill Education Private Limited, ISBN: 10: 0070678790.
2	Real-Time Concepts for Embedded Systems, Qing Li, Edition 2003, CMP publishers.
3	Embedded Systems – A contemporary Design Tool, James K Peckol, 2008, John Weily, ISBN:0-444-51616-6.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +50(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	---	---	---	---	---	---	1	---	---	---
CO2	3	1	---	---	---	---	---	---	1	---	---	---
CO3	3	3	3	2	2	---	---	---	2	---	---	2
CO4	3	3	3	2	2	---	---	---	2	---	---	2

High-3: Medium-2: Low-1

Semester: VII						
CELLULAR MOBILE NETWORK (GROUP G: PROFESSIONAL ELECTIVE) (Theory)						
Course Code	**:**	**16TE7G1**		**CIE**	**:**	**100 Marks**
Credits: L:T:P :S	**:**	**4 : 0 : 0 : 0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Describe Wireless networks, architecture of wireless networks and cell acquisition.
2	Analyze the concepts protocols used, spectrum allocation.
3	Compare the concepts of different standards and their architecture.
4	Differentiate wireless networks for various applications and QoS.

UNIT-I	**08 Hrs**
Basics of Wireless Networks: Wireless Network, Wireless switching technology, Wireless Communication Problems, Wireless Network reference model, Wireless Networking issues, Wireless Networking standards.	
UNIT-II	**08 Hrs**
Architectural Review of UMTS and GSM: History of Mobile Telecommunication Systems, LTE, UMTS to LTE, LTE-Advanced, 3GPP Specifications for LTE. **Architecture of LTE:** Communication Protocols , Bearer Management, Spectrum Allocation Wireless Communications, Radio Transmission and Reception, Multipath fading and inter symbol interference, Error Management.	
UNIT-III	**08 Hrs**
Architecture of the LTE Air Interface: Air Interface Protocol Stack, Logical Transport and Physical Channels, The Resource Grid, Multiple Antenna Transmission, Resource Element Mapping. **Cell Acquisition:** Acquisition Procedure, Synchronization Signals, Downlink Reference Signals, Physical Broadcast Channel, Physical Control Format Indicator Channel, System Information, Procedures After Acquisition.	
UNIT-IV	**08 Hrs**
Data transmission and reception: Data Transmission Procedures, Transmission of Scheduling Messages on the PDCCH, Data Transmission on the PDSCH and PUSCH, Transmission of Hybrid ARQ Indicators on the PHICH, Uplink Control Information. Transmission of Uplink Control Information on the PUCCH, Uplink Reference Signals, Uplink Power Control, Discontinuous Reception.	
UNIT-V	**08 Hrs**
Quality of service: Policy and Charging Control, Quality of Service Parameters, Policy Control Architecture, Session Management Procedures, Charging and Billing.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain wireless networks, architecture of wireless networks and cell acquisition system.
CO2	Analyze the concepts and network architectures of mobile generation networks.
CO3	Apply the concepts of different standards and their architectures to understand the real time problems in mobile networks.
CO4	Evaluate wireless networks for various applications to achieve QoS.

Reference Books	
1	An Introduction to LTE, Christopher Cox, 2012, Wiley (e-Book).
2	LTE-The UMTS long term evolution, SteffeniaSesia, IssamToufik, Matthew Baker, 2011, Wiley (e-Book).

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +50(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	-	1	1	-	2	-	1	-	2	3	-	1
CO3	1	3	2	2	2	2	1	1	3	3	2	2
CO4	1	1	2	2	2	1	-	-	2	3	-	1

High-3: Medium-2: Low-1

Semester: VII						
DSP APPLICATIONS (GROUP G: PROFESSIONAL ELECTIVE) (Theory)						
Course Code	**:**	**16TE7G2**		**CIE**	**:**	**100 Marks**
Credits: L:T:P :S	**:**	**4 : 0 : 0 : 0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Explain the process of up sampling and down sampling of signals.
2	Design the filter banks and M-channel QMF bank.
3	Design an adaptive filter based on LMS/RLS algorithm for different applications.
4	Explain the various concepts of Image Processing such as filtering, histogram, compression etc.
5	Describe various applications such as audio, CD, mobile, telephony and set top box.

UNIT-I	**09 Hrs**
FIR filter Design: FIR filter Characteristics, Specifications, design steps; Coefficient calculation; Window Method; Optimal Method; Frequency Sampling Method; Comparison of different methods; Structures for FIR filters – Linear Phase and Lattice methods.	
UNIT-II	**09 Hrs**
Multi-rate Digital Signal Processing: Introduction, Concepts of multirate signal processing – decimation, interpolation, sampling rate conversion; design of practical sampling rate converters; Poly phase structures for sampling rate conversion. Application Examples.	
UNIT-III	**09 Hrs**
Adaptive Filters: Use of adaptive filters; Concepts of adaptive filtering; Weiner filter theory; Basic LMS adaptive algorithm; Recursive least squares algorithm; Applications – Noise cancellation, System modeling, adaptive telephone echo cancellation, multi-path effect cancellation, Jammer suppression, adaptive signal enhancement.	
UNIT-IV	**09 Hrs**
Image Processing Basics: Notation and Data formats; Histogram and Equalization; Image level adjustment and contrast; Image filtering enhancement; Pseudo-color generation and detection; Image spectra; Image compression.	
UNIT-V	**09 Hrs**
Applications: Audio applications – digital audio mixing, speech synthesis and recognition, CD digital audio system, High quality ADC for digital audio, DAC for hi-fi systems, multirate narrow band digital filtering, high resolution narrow band spectral analysis. CD recording system, Transmultiplexers – TDM to FDM conversion, FDM to TDM conversion; Telecommunication applications – digital cellular mobile telephony, set-top box for digital TV.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the importance and functions of Decimator, Interpolator, Adaptive filters and its applications.
CO2	Apply different DSP operations for various data.
CO3	Design and Analyze filter banks and Adaptive filters.
CO4	Develop signal processing algorithms for various applications.

Reference Books	
1	Digital Signal Processing – A Practical approach, E.C.Ifeachor and B.W.Jervis, 2nd Edition, 2002, Pearson Education.
2	Digital Signal Processing – Fundamentals and Applications, Li Tan , 2008, Elsevier.
3	Digital Signal Processing, Proakis and Monolakias, 4th Edition, 2006, Pearson/PHI, ISBN: 81-317-1000-9.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE is 30(Q) +50(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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CO1	3	---	3	---	3	---	---	---	1	---	---	2
CO2	3	---	3	---	3	---	---	---	1	2	---	2
CO3	3	3	---	3	2	1	---	---	---	---	---	2
CO4	2	2	1	2	---	2	1	---	2	2	--	3

High-3: Medium-2: Low-1

Semester: VII						
ADHOC NETWORKS (GROUP G: PROFESSIONAL ELECTIVE) (Theory)						
Course Code	**:**	**16TE7G3**		**CIE**	**:**	**100 Marks**
Credits: L:T:P :S	**:**	**4 : 0 : 0 : 0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the basics and applications of Ad -hoc Networks.
2	Learn various fundamental and emerging protocols of all layers in ad-hoc network.
3	Study the issues pertaining to major obstacles in establishment and efficient management of ad-hoc networks.

UNIT-I	**08 Hrs**
Ad Hoc wireless networks: Introduction, Issues in Ad hoc wireless networks, Adhoc wireless internet.	
UNIT-II	**08 Hrs**
MAC protocols for Ad Hoc wireless networks: Introduction, Issues in designing MAC protocol for ad hoc wireless networks, Design goals of a MAC protocol for Ad hoc wireless networks, Classifications of MAC protocols, Contention-based protocols, Contention-based protocols with reservation mechanisms, Contention-based MAC protocols with scheduling mechanisms.	
UNIT-III	**08 Hrs**
Routing Protocols For Ad Hoc Wireless Networks: Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols, Table Driven Routing Protocols: Destination Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP) , Source-Tree adaptive routing protocol. On- Demand Routing protocols: Ad hoc On Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR) , Temporally Ordered Routing Algorithm (TORA) ,Location Aided Routing (LAR). Hybrid Routing Protocols: Core Extraction distributed Ad Hoc routing protocol, Zone Routing Protocol (ZRP), Zone-Based Hierarchical Link State Routing Protocol.	
UNIT-IV	**08 Hrs**
Multicast Routing In Ad Hoc Wireless Networks: Issues in Designing a Multicast Routing Protocol ,Operation of Multicast Routing protocol, An Architecture Reference Model for Multicast Routing protocol, Classifications of Multicast Routing Protocols , Tree Based Multicast Routing Protocols: Bandwidth-Efficient multicast routing protocol, Multicast routing protocol based on Zone routing, Multicast Core-Extraction distributed Ad hoc routing, Associativity-Based Ad hoc multicast routing, Mesh Based Multicast Routing Protocols: On-Demand multicast routing protocol, Dynamic Core-Based multicast routing protocol, Forwarding group Multicast protocol.	
UNIT-V	**08 Hrs**
Transport Layer And Security: Issues in Designing a Transport Layer Protocol for Adhoc Wireless Networks, Design Goals of a Transport Layer Protocol for Adhoc Wireless Networks, Classification of Transport Layer Solutions, TCP over Ad hoc Wireless Networks. Other Transport Layer protocols for Ad hoc Wireless Networks.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the concepts and applications of ad-hoc networks.
CO2	Analyze the technology trends for the implementation and deployment of wireless Ad-hoc networks.
CO3	Analyze the challenges in designing protocol stacks for ad-hoc networks.
CO4	Analyze various protocols of all layers in ad-hoc network.

Reference Books	
1	Ad Hoc Wireless Networks Architectures and Protocols, C. Siva Ram Murthy and B. S. Manoj, 2004, Prentice Hall, ISBN : 978-81-317-0688-6.
2	Ad Hoc Mobile Wireless Networks Protocols and Systems, K. Toh, 2001, Prentice Hall, PTR, ISBN, 0130078174.
3	Ad Hoc Networking, Charles E. Perkins, 2000. Addison Wesley, ISBN-13: 978-032157907.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE is 30(Q) +50(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

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CO1	1	2	---	2	---	---	---	---	---	---	---	---
CO2	3	3	---	3	---	2	---	---	1	---	---	2
CO3	2	3	---	2	---	2	---	---	1	---	---	2
CO4	2	3	---	3	---	2	---	---	1	---	---	2

High-3: Medium-2: Low-1

Semester: VII						
INTERNET OF THINGS (IoT) **(GROUP G: PROFESSIONAL ELECTIVE)** **(Theory)**						
Course Code	**:**	**16TE7G4**		**CIE**	**:**	**100 Marks**
Credits: L:T:P :S	**:**	**4 : 0 : 0 : 0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**45L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the basics of Internet of Things.
2	Identify the applications of IoT with respect to today's aspect.
3	Analyze the importance of IoT protocols and architectures.
4	Create case studies for given applications of IoT.

UNIT-I	**09 Hrs**
Introduction to Networking basics and Internet of Things: OSI Model, IP Addressing, Network Topologies, Sub-netting, History of IoT, Definitions,and.Functional,Requirements,Motivation,M2M communications, Architecture, Ubiquitous IoT Applications, Four Pillars of IoT, IoT physical entities, Introduction to Web Servers and Cloud Computing.	
UNIT-II	**09 Hrs**
IoT Communication Technologies: IoT Communication Pattern, IoT protocol Architecture, NFC, RFID, Bluetooth, BLE, Zigbee, Wifi, RF links, Mobile Internet, Wired Communication, The 6LoWPAN Security aspects in IoT, Mobility support, Design factors, Design issues and challenges, Application Protocols: MQTT, HTTP, CoAP, MySQL.	
UNIT-III	**09 Hrs**
IoT Web Services: Introduction to WSDL, SOAP, Web Services: Service Oriented Architecture: SOA to implement Web Services, XML, SAAS, PAAS, IAAS, Public, Private and Hybrid cloud deployment models, Benefits, challenges and risks of cloud computing models, Introduction to cloud based IoT platforms like IBM Bluemix, carriot etc, Data Analytics / Big Data and Data Visualization.	
UNIT-IV	**09 Hrs**
IoT Application Development: Back-end Application Designing Apache for handling HTTP Requests, PHP & MySQL for data processing, MongoDB Object type Database, HTML, CSS & jQuery for UI Designing, JSON lib for data processing, Security & Privacy during development, Application Development for mobile Platforms: Overview of Android / IOS App Development tools.	
UNIT-V	**09 Hrs**
Data Modeling, Security and Interoperability: Modes of attack: DoS, Guessing the credentials, Getting access to stored credentials, Man in the middle, Sniffing network communication, Port scanning and Web scrawling, Tools for achieving security: VPN, Need for Interoperability, Case studies – Open Source e-Health sensor platform, Smart Grid – Electrical Vehicle Charging and Other recent projects.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain fundamental concepts of Internet of Things.
CO2	Analyze various communication protocols for IoT.
CO3	Develop web services to access IoT devices.
CO4	Develop an IoT application and various case studies for the real time applications.

Reference Books	
1	The Internet of Things in the Cloud: A Middleware Perspective", Honbo Zhou , Pages 391, 2012, CRC Press, ISBN: 9781439892992.
2	Architecting the Internet of Things, Dieter Uckelmann; Mark Harrison; Florian Michahelles, 2011, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-19157-2,
3	The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, OmarElloumi, Pages: 370, 2012, Wiley, ISBN: 978-1-119-99435-0.
4	Internet of Things – A hands-on approach", ArshdeepBahga, Vijay Madisetti, Pages: 520, Universities Press, Orient Blackswan Private Limited, ISBN: 978-8173719547 2015

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +50(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	1	1	1	-	1	1	1	2	3	-	1
CO2	1	2	2	2	-	1	1	1	2	3	-	1
CO3	-	-	3	1	1	-	-	1	2	3	1	1
CO4	3	2	3	1	-	1	1	2	2	3	1	1

High-3: Medium-2: Low-1

Semester: IV						
NANOTECHNOLOGY **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H01**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**36L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	To have the basic knowledge of nanomaterials and the process.
2	Describe methods of nanoscale manufacturing and characterization can be enabled.
3	To learn about Nano sensors and their applications in mechanical, electrical, electronic, Magnetic, Chemical field.
4	To understand the concept for a nanoscale product based on sensing, transducing, and actuating mechanism.
5	To have awareness about the nanoscale products used in multidisciplinary fields.

Unit-I	**06 Hrs**
Introduction to Nanomaterials: History of Nanotechnology, structures and properties of carbon based: Fullerenes (Bucky Ball, Nanotubes), metal based: Nano Shells, Quantum Dots, Dendrimers, Diamond like carbon(DLC) Nanocarriers, bionanomaterails: protein & DNA based nanostructures, Hybrids: hybrid biological/inorganic, Nanosafety Issues: Toxicology health effects caused by nanoparticles.	
Unit – II	**08 Hrs**
Characterization of Nanostructures: Spectroscopy: UV-Visible spectroscopy, Fourier Transform infrared spectroscopy (FTIR), Raman Spectroscopy, X-ray spectroscopy. **Electron microscopy**: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM).**Scanning probe microscopy**: Atomic Force microscopy (AFM), Scanning tunnel microscopy (STM). **Nano Synthesis and Fabrication**: Introduction & overview of Nanofabrication: Bottom up and Top down approaches using processes like Ball milling, Sol-gel Process, Chemical Vapour deposition (CVD), plsma arching and various lithography techniques (Hard & Soft lithography).	
Unit –III	**09 Hrs**
Nanosensors: Overview of nanosensors, prospects and market. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, Mechanics of CNTs, Biosensors: Biosensors in modern medicine.	
Unit –IV	**06 Hrs**
Micro & Nano-Electromechanical systems and Microfluidics: MEMS/NEMS: Magnetic, Chemical and Mechanical Transducers –Sensing and Actuators. Microfludics: Laminar flow, Hagen-Peouiselle equation, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps.	
Unit –V	**07 Hrs**
Applications of Nanotechnology: Molecular electronics, molecular switches, mechanical cutting tools, machine components, DLC coated grinding wheels. solar cells, Batteries, fuel cells, Nanofilters. Medical nanotechnology: in Diagnostics, Therapeutics, Drug delivery and Nanosurgery.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Remember, understand, and apply knowledge about of nanomaterials and their uses.
CO2	Interpret and apply the techniques of manufacturing and characterization processes
CO3	Apply the knowledge of Nanosensors, related to nanosensors in electronics, mechanical, chemical, and biological systems.
CO4	Create and evaluate nano Design, Devices and Systems in various disciplines

Reference Books	
1	B.S. Murty., P. Shankar., B.Raj, B..B. Rath, and J. Murday, Textbook of Nanosciences and Nanotechnology, Springer, Co-publication with University Press (India) Pvt. Ltd. VCH, XII.1st Edition, 2013, ISBN- 978-3-642-28030-6.
2	V. K. Khanna, Nanosensors:, Physical, Chemical and Biological, CRC press, 1st edition, 2013, ISBN 9781439827123 (Unit III).
3	C. C. Kock., Nanostructured materials, Nanostructured materials, William Andrew Publishing, 2nd edition, 2007, ISBN 0-8155-1534-0.
4	M .Wilson., K. Kannangara., G.Smith., M.Simmons., B. Raguse., Nanotechnology, , overseas Press (India) Private Ltd.,1st edition, 2005,ISBN 81-88689-20-3.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INDUSTRIAL SAFETY AND RISK MANAGEMENT (Group H: Global Elective) (Theory)						
Course Code	**:**	**16G7H02**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**36L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the basics of risk assessment methodologies
2	Select appropriate risk assessment techniques
3	Analyze public and individual perception of risk
4	Relate safety, ergonomics and human factors
5	Carry out risk assessment in process industries

Unit-I	**08 Hrs**
General Risk Identification Methods – I: Hazard identification methodologies, risk assessment methods-PHA, HAZOP, MCA, consequence analysis, hazards in workplaces-nature and type of work places, types of hazards, hazards due to improper housekeeping, hazards due to fire in multi floor industries and buildings.	
Unit – II	**07 Hrs**
Risk Assessment Methods – II: Risk adjusted discounted rate method, certainty equivalent coefficient method, quantitative analysis, probability distribution, coefficient of variation method, Simulation method, Shackle approach, Hiller‟s model, Hertz Model.	
Unit –III	**07 Hrs**
Risk Management – III: Emergency relief Systems, Diers program, bench scale experiments, design of emergency relief systems, risk management plan, mandatory technology option analysis, risk management alternatives, risk management tools, risk management plans, risk index method, Dowfire and explosion method, Mond index Method.	
Unit –IV	**07 Hrs**
Risk Assurance and Assessment – IV: Property insurance, transport insurance, liability insurance, risk Assessment, low Probability high consequence events. Fault tree analysis, Event tree analysis.	
Unit –V	**07Hrs**
Risk Analysis in Chemical Industries– V: Handling and storage of chemicals, process plants, personnel protection equipment's. International environmental management system.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Recall risk assessment techniques used in process industry.
CO2	Interpret the various risk assessment tools.
CO3	Use hazard identification tools for safety management.
CO4	Analyze tools and safety procedures for protection in process industries.

Reference Books	
1	Kirkcaldy K.J.D Chauhan, Functional Safety in the Process Industry : A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84, North corolina, Lulu publication, 2012, ISBN:1291187235
2	Goble and William M. Safety Instrumented Systems Verification Practical probabilistic calculations, Pensulvania ISA publication, 2005, ISBN:155617909X.
3	Laird Wilson and Doug Mc Cutcheon. Industrial safety and risk Management, The University of Alberta press, Canada, 1st Edition, 2003, ISBN: 0888643942.

4	Sincero A P and Sincero G A Environmental Engineering – A Design Approach,Prentice Hall of India, New Delhi,1996, ISBN: 0024105643.
5	Pandya C G, Risks in Chemical units, Oxford and IBH publications, New Delhi, 1992, ISBN: 8120406907

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INTELLIGENT TRANSPORT SYSTEM **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H03**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**36L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand basic traffic flow and control for ITS.
2	Understand user services for application in transportation system.
3	Understand ITS architecture and its planning at various levels.
4	Evaluate user services at various levels.

Unit – I	**8 Hrs**
Introduction: –Historical Background, Definition, Future prospectus, ITS training and educational needs. **Fundamentals of Traffic Flow and Control**- Traffic flow elements, Traffic flow models, Shock waves in Traffic streams, Traffic signalization and control principles, Ramp metering, Traffic simulation	
Unit – II	**6 Hrs**
ITS User services-User services bundles, Travel and Traffic management, Public Transportation Operations, Electronic Payment, Commercial Vehicles Operations, Emergency Management, Advanced Vehicle Control and safety systems, Information Management, Maintenance and construction Management	
Unit –III	**7 Hrs**
ITS Applications and their benefits-Freeway and incident management systems-objectives, functions, traffic Surveillance and incident detection, Ramp control, incident management, Advanced arterial traffic control systems- historical development, Adaptive traffic control algorithms, Advanced Public Transportation Systems-Automatic vehicle location systems, Transit Operations software and information systems, Electronic fare payment systems, Multimodal Traveler Information systems	
Unit –IV	**7 Hrs**
ITS Architecture-Regional and Project ITS Architecture, Need of ITS architecture, concept of Operations, National ITS Architecture, Architecture development tool. **ITS Planning**-Transportation planning and ITS, Planning and the National ITS Architecture, Planning for ITS, Integrating ITS into Transportation Planning, relevant case studies.	
Unit –V	**8 Hrs**
ITS Standards-Standard development process, National ITS architecture and standards, ITS standards application areas, National Transportation Communications for ITS Protocol, Standards testing. **ITS Evaluation** – Project selection at the planning level, Deployment Tracking, Impact Assessment, Benefits by ITS components, Evaluation Guidelines, Challenges and Opportunities.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify various applications of ITS
CO2	Apply ITS applications at different levels.
CO3	Examine ITS architecture for planning process.
CO4	Define the significance of ITS for various levels

Reference Books	
1	Fundamentals of Intelligent Transportation Systems Planning, Choudury M A and Sadek A, Artech House publishers (31 March 2003), ISBN-10: 1580531601
2	Intelligent transportation systems standards, Bob Williams, 2008, Artech House, London, ISBN-13: 978-1-59693-291-3.
3	Intelligent Transport Systems: Technologies and Applications, Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola, Wiley Publishing ©2015, ISBN:1118894782 9781118894781.
4	ITS Hand Book 2000 Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
5	Intelligent Transport Systems, Dominique Luzeaux ‚Jean-René Ruault, Michel Chavret" 7 MAR 2013 Copyright © 2010, John Wiley & Sons, Inc DOI: 10.1002/9781118557495.ch6

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks are executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INTELLIGENT SYSTEMS **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H04**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**36L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand fundamental AI concepts and current issues.
2	Understand and apply a range of AI techniques including search, logic-based reasoning, neural networks and reasoning with uncertain information.
3	Recognize computational problems suited to an intelligent system solution.
4	Identify and list the basic issues of knowledge representation, blind and heuristic search.

Unit-I	**07 Hrs**
Introduction: The Foundations of Artificial Intelligence, History of Artificial Intelligence, The State of the Art, **Intelligent Agent:** Introduction, How Agents Should Act, Structure of Intelligent Agents, **Problem-solving**: Solving Problems by Searching Search Strategies, Avoiding Repeated States, Avoiding Repeated States.	
Unit – II	**07 Hrs**
Informed Search Methods: Best-First Search, Heuristic Functions, Memory Bounded Search, Iterative Improvement Algorithms. **Game Playing:** Introduction: Games as Search Problems, Perfect Decisions in Two-Person, Games Imperfect Decisions, Alpha-Beta Pruning, Games That Include an Element of Chance.	
Unit –III	**07 Hrs**
Knowledge Inference: Knowledge representation -Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning - Certainty factors, Bayes Rule, Uncertainty Principles, Bayesian Theory-Bayesian Network-Dempster - Shafer theory.	
Unit –IV	**07 Hrs**
Learning from Observations: A General Model of Learning Agents, Inductive Learning, Learning Decision Trees, Using Information Theory, Learning General Logical Descriptions, Why Learning Works: Computational Learning Theory. **Reinforcement Learning:** Passive Learning in a Known Environment, Passive Learning in an Unknown Environment, Active Learning in an Unknown Environment.	
Unit –V	**07 Hrs**
Expert Systems, Components, Production rules, Statistical reasoning, certainty factors, measure of belief and disbelief, Meta level knowledge, Introspection. Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand and explore the basic concepts and challenges of Artificial Intelligence.
CO2	Analyze and explain basic intelligent system algorithms to solve problems.
CO3	Apply Artificial Intelligence and various logic-based techniques in real world problems.
CO4	Assess their applicability by comparing different Intelligent System techniques

Reference Books	
1	AI – A Modern Approach ,Stuart Russel, Peter Norvig , 2nd Edition, Pearson Education, 2010, ISBN:13: 978-0137903955.
2	Artificial Intelligence (SIE) ,Kevin Night, Elaine Rich, Nair B., ,McGraw Hill, 1st Edition, 2008, ISBN: 9780070087705.
3	Introduction to AI and ES , Dan W. Patterson, Pearson Education, 1st Edition ,2007. ISBN: 0132097680.
4	Introduction to Expert Systems , Peter Jackson, 3rd Edition, Pearson Education, 2007, ISBN: 978-0201876864.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 60 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	2	2	1	2	-	2	2
CO2	3	3	3	3	3	2	2	1	2	-	2	2
CO3	3	3	3	3	3	2	1	1	2	-	2	2
CO4	3	3	3	3	3	1	2	1	1	1	2	2

High-3: Medium-2: Low-1

Semester: VII						
IMAGE PROCESSING AND MACHINE LEARNING **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H05**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**3:0:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**03 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the major concepts and techniques in image processing and Machine Learning
2	To explore, manipulate and analyze image processing techniques
3	To become familiar with regression methods, classification methods, clustering methods.
4	Demonstrate image processing and Machine Learning knowledge by designing and implementing algorithms to solve practical problems

Unit-I	**08 Hrs**
Introduction to image processing: Images, Pixels, Image resolution, PPI and DPI, Bitmap images, Lossless and lossy compression, Image file formats, Color spaces, Bezier curve, Ellipsoid, Gamma correction, Advanced image concepts.	
Unit – II	**08 Hrs**
Basics of Python & Scikit image: Basics of python, variables & data types, data structures, control flow & conditional statements, uploading & viewing an image, Image resolution, gamma correction, determining structural similarities.	
Unit –III	**08 Hrs**
Advanced Image processing using Open CV: Blending Two Images, Changing Contrast and Brightness Adding Text to Images Smoothing Images , Median Filter ,Gaussian Filter ,Bilateral Filter ,Changing the Shape of Images ,Effecting Image Thresholding ,Calculating Gradients , Performing Histogram Equalization.	
Unit –IV	**08 Hrs**
Machine Learning Techniques in Image Processing: Bayesian Classification, Maximum Likelihood Methods, Neural Networks; Non-parametric models; Manifold estimation, Support Vector Machines, Logistic Regression.	
Unit –V	**08 Hrs**
Introduction to object Tracking , Modeling & Recognition: Exhaustive vs. Stochastic Search, Shapes, Contours, and Appearance Models. Mean-shift tracking; Contour-based models, Adaboost approaches: Face Detection / Recognition, Tracking.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Gain knowledge about basic concepts of Image Processing.
CO2:	Identify machine learning techniques suitable for a given problem.
CO3:	Write programs for specific applications in image processing.
CO4:	Apply different techniques for various applications using machine learning techniques.

Reference Books	
1	Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python, Himanshu Singh, Apress publisher.
2	Pattern Recognition and Machine Learning, Christopher Bishop, Springer, 2008
3	Computer Vision: A modern Approach, David Forsyth and Jean Ponce, Prentice Hall India 2004.
4	Machine Vision : Theory Algorithms Practicalities, E.R. Davies Elsevier 2005.
5	Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods Pearson Education, Ed, 2001.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

SEMESTER: VII						
DESIGN OF RENEWABLE ENERGY SYSTEMS (GROUP H: GLOBAL ELECTIVE) (Theory)						
Course Code	**:**	**16G7H06**		**CIE Marks**	**:**	**100**
Credits: L:T:P:S	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**40L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives:

1	To provide opportunity for students to work on multidisciplinary projects.
2	To familiarize the students with the basic concepts of nonconventional energy sources and allied technological systems for energy conversion
3	To impart skill to formulate, solve and analyze basic Non – conventional energy problems and prepare them for graduate studies.
4	To enable the student to design primarily solar and wind power systems.
5	To expose the students to various applications of solar, wind and tidal systems.

UNIT – I	**07 Hrs**
An introduction to energy sources: Industry overview, incentives for renewable, utility perspective, Relevant problems discussion, current positions of renewable energy conditions.	
UNIT – II	**09 Hrs**
PV Technology: photovoltaic power, PV projects, Building-integrated PV system, PV cell technologies, solar energy maps, Technology trends, **Photovoltaic Power Systems**: PV cell, Module and Array, Equivalent electrical circuit, open-circuit voltage and short-circuit current, I-V and P-V curves, Array design (different methodologies), peak-power operation, system components.	
UNIT – III	**09 Hrs**
Wind Speed and Energy: Speed and power relations, power extracted from the wind, Air density, Global wind patterns, wind speed distribution (parameters calculations) , wind speed prediction, **Wind Power Systems :** system components , turbine rating , power vs. speed and TSR, maximum energy capture, maximum power operation, system-design trade-offs , system control requirements, environmental aspects.	
UNIT – IV	**07 Hrs**
Geothermal and ocean energy: Geothermal power, geo pressured sources, Geothermal well drilling, advantages and disadvantages, Comparison of flashed steam and total flow concept. **Energy from ocean**: OTEC power generation, OPEN and CLOSED cycle OTEC. Estimate of Energy and power in simple single basin tidal and double basin tidal system.	
UNIT – V	**08 Hrs**
Stand alone system: PV stand-alone, Electric vehicle, wind standalone, hybrid systems (case study), system sizing, wind farm sizing. **Grid-Connected Systems: i**ntroduction**,** interface requirements, synchronizing with the grid, operating limit, Energy storage and load scheduling**,** Grid stability issues**,** distributed power generation.	

Course outcomes:

CO1: Demonstrate an understanding of the scientific principles of methodology of Non-conventional energy.
CO2: Acquire working knowledge of different Renewable energy science-related topics.
CO3: Ability to analyze the system related concepts effectively in the wind energy designing.
CO4: Students will be able to decide the appropriate procedures to ensure that the working model has developed properly.

Reference Books	
1.	Wind and Solar Power Systems Design, Analysis and operation, Mukund R Patel, 2nd Edition, 2006, Taylor and Francis publishers, ISBN 978-0-8493-1570-1.
2.	Non-Conventional sources of energy, G.D.Rai, 4th Edition, 2009, Khanna Publishers, ISBN 8174090738, 9788174090737.
3.	Solar Energy, Sukhatme, 4th Edition, 2017, McGraw Hill Education, **ISBN-13:** 978-9352607112.
4.	Renewable energy sources, John Twidell, Tony Weir, 3rd Edition, 2015, Routledge Publisher, ISBN-13: 978-0415584388.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

VII Semester						
SYSTEMS ENGINEERING **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H07**		**CIE Marks**	**:**	**100**
Credits: L:T:P:S	**:**	**3:0:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**33L**		**SEE Duration**	**:**	**03 Hours**

Course Learning Objectives:	
1	Develop an appreciation and understanding of the role of systems engineering processes and systems management in producing products and services.
2	Document systematic measurement approaches for generally cross disciplinary development effort.
3	Discuss capability assessment models to evaluate and improve orgnizational systems engineering capabilities.

Unit-I	**07 Hrs**
System Engineering and the World of Modem System: What is System Engineering?, Origins of System Engineering, Examples of Systems Requiring Systems Engineering, System Engineering viewpoint, Systems Engineering as a Profession, The power of Systems Engineering, problems. **Structure of Complex Systems:** System building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions. **The System Development Process:** Systems Engineering through the system Life Cycle, Evolutionary Characteristics of the development process, The system engineering method, Testing throughout system development, problems.	
Unit – II	**07 Hrs**
Systems Engineering Management: Managing systems development and risks, Work breakdown structure (WBS), System Engineering Management Plan (SEMP), Risk Management, Organization of Systems Engineering, Systems Engineering Capability Maturity Assessment, Systems Engineering standards, Problem. **Needs Analysis:** Originating a new system, Operations analysis, Functional analysis, Feasibility analysis, Feasibility definition, Needs validation, System operational requirements, problems. **Concept Exploration:** Developing the system requirements, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Performance requirements validation, problems.	
Unit – III	**07 Hrs**
Concept Definition: Selecting the system concept, Performance requirements analysis, Functional analysis and formulation, Concept selection, Concept validation, System Development planning, System Functional Specifications, problems **Advanced Development:** Reducing program risks, Requirements analysis, Functional Analysis and Design, Prototype development, Development testing, Risk reduction, problems.	
Unit – IV	**06 Hrs**
Engineering Design: Implementing the System Building blocks, requirements analysis, Functional analysis and design, Component design, Design validation, Configuration Management, problems. **Integration and Evaluation:** Integrating, Testing and evaluating the total system, Test planning and preparation, System integration, Developmental system testing, Operational test and evaluation, problems.	
Unit – V	**06 Hrs**
Production: Systems Engineering in the factory, Engineering for production, Transition from development to production, Production operations, Acquiring a production knowledge base, problems. **Operations and support**: Installing, maintenance and upgrading the system, Installation and test, In-service support, Major system upgrades: Modernization, Operational factors in system development, problems.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the Life Cycle of Systems.
CO2	Explain the role of Stake holders and their needs in organizational systems.
CO3	Develop and Document the knowledge base for effective systems engineering processes.
CO4	Apply available tools, methods and technologies to support complex high technology systems.
CO5	Create the frameworks for quality processes to ensure high reliability of systems.

Reference Books	
1	Systems Engineering – Principles and Practice, Alexander Kossoakoff, William N Sweet, 2012, John Wiley & Sons, Inc, ISBN: 978-81-265-2453-2
2	Systems Engineering and Analysis, Blanchard, B., and Fabrycky W, 5th Edition, 2010, Saddle River, NJ, USA: Prentice Hall.
3	Handbook of Human Systems Integration, Booher, H. (ed.) 2003. Hoboken, NJ, USA: Wiley.
4	Systems Engineering: A 21st Century Methodology, Hitchins, D., 2007. Chichester, England: Wiley.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
MEMS AND APPLICATIONS **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H08**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**35L**		**SEE Duration**	**:**	**3.00 Hours**
Course Learning Objectives: The students will be able to						
1	Understand the rudiments of Micro fabrication techniques.					
2	Identify and associate the various sensors and actuators to applications.					
3	Analyze different materials used for MEMS.					
4	Design applications of MEMS to disciplines.					

Unit - I	**06 Hrs**
Overview of MEMS & Microsystems: MEMS and Microsystems, Typical MEMS and micro system products, Evolution of micro fabrication, Microsystems and microelectronics, Multidisciplinary nature of Microsystems, Design and manufacture, Applications of Microsystems in automotive, healthcare, aerospace and other industries. **Working Principle of Microsystems**: Biomedical and biosensors. Micro sensors: Acoustic, Chemical, Optical, Pressure, Thermal.	
Unit – II	**08 Hrs**
Micro actuation: Using thermal forces, shape memory alloys, Piezoelectric crystals and electrostatic forces. MEMS with micro actuators: Microgrippers, micromotors, microvalves and micropumps, microaccelerometers, microfluidics**.** **Introduction to Scaling:** Scaling in Geometry, Scaling in Rigid body dynamics, Scaling in Electrostatic forces, scaling in electromagnetic forces and scaling in fluid mechanics.	
Unit – III	**08 Hrs**
Materials for MEMS and Microsystems: Substrates and wafers, Active substrate materials, Silicon as substrate material, Silicon Compounds, Si-Piezoresistors, GaAs, Quartz, Piezoelectric Crystals, Polymers and packaging materials. Three level of Microsystem packaging, Die level packaging, Device level packaging, System level packaging. Interfaces in microsystem packaging. Essential packaging technologies: die preparation, Surface bonding, Wire bonding, Sealing, 3D packaging.	
Unit – IV	**06 Hrs**
Microsystem Fabrication Process: Introduction to microsystems, Photolithography, Ion Implantation, Diffusion, Oxidation, CVD,PVD-Sputtering, Deposition of Epiaxy, Etching, LIGA process: General description, Materials for substrates and photoresists, Electroplating and SLIGA process.	
Unit – V	**07 Hrs**
Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia, Acoustic, Tactile and Flow sensors. **Overview, Application, Fabrication Process in Applications:** Silicon Capacitive Accelerometer, Piezo resistive Pressure sensor, Electrostatic Comb drive, Portable blood analyzer, Piezo electric Inkjet Print head, Micromirror array for Video projection.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the operation of micro devices, micro systems and their applications.
CO2	Apply the principle of material science to sensor design.
CO3	Analyze the materials used for sensor designs.
CO4	Conceptualize and design micro devices, micro systems.

Reference Books	
1	MEMS & Microsystems Design and Manufacture, Tai-Ran Hsu, 2nd Edition, 2002, Tata McGraw Hill Education, New Delhi, ISBN-13:978-0-07-048709-3.
2	Foundations of MEMS, Chang Liu, 2012, Pearson Education Inc., ISBN-13:978-0-13-249736-7.
3	Smart Material Systems and MEMS, Vijay K Varadan, K. J. Vinoy, S. Gopalakrishnan, 2006, Wiley-INDIA, ISBN-978-81-265-3170-7.
4	Micro and Smart Systems, G.K. Ananthasuresh, K.J .Vinoy, K.N. Bhat, V.K. Aatre, 2015, Wiley Publications, ISBN-:978-81-265-2715-1.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INTRODUCTION TO INTERNET OF THINGS **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H09**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Learn the fundamentals of IoT.
2	Understands the hardware, networks & protocols used in IoT development.
3	Illustrate smart applications using IoT devices and building applications.
4	Know more advanced concepts like cloud connectivity in IoT.
5	Learn the fundamentals of IoT.

Unit-I	**06 Hrs**
Fundamentals Of IOT: Introduction, Physical design of IoT, Logical design of IoT, IoT Enabling technologies, IoT Levels and Deployment Templates, IoTvs M2M.	
Unit – II	**06 Hrs**
IOT Design Methodology: Need for IoT systems management, IoT Design Methodology **Internet of Things Strategic Research and Innovation Agenda:** Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Smart-X Applications, Internet of Things and Related Future Internet Technologies.	
Unit –III	**11 Hrs**
IOT Systems: Logical Design using Python: Provides an introduction to Python, installing Python, Python data types & data structures, control flow, functions, modules, packages, file input/output, data/time operations and classes.	
Unit –IV	**09 Hrs**
IOT Physical Devices & Endpoints: What is an IoT device, Raspberry Pi device, About the board, Linux on Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python.	
Unit –V	**07 Hrs**
IOT Physical Servers & Cloud Offerings: Provides an introduction to the use of cloud platforms and frameworks such as Xively and AWS for developing IoT applications.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the fundamentals of IoT.
CO2	Analyse the IoT devices, programming, networking requirements and protocols for building IoT products.
CO3	Apply the concepts to design and develop IoT applications
CO4	Creating applications of IoT using physical devices and interfacing with cloud.

Reference Books	
1	Internet of Things (A Hands-on-Approach), Vijay Madisetti and ArshdeepBahga, 1st Edition, VPT, 2014, ISBN-13: 978-0996025515.
2	Internet of Things – From Research and Innovation to Market Deployment, OvidiuVermesan, Peter Friess, River Publishers Series in Communication, River Publishers, 2014, ISBN: ISBN: 978-87-93102-94-1 (Hard copy), 978-87-93102-95-8 (Ebook) (UnitsII 2nd part).
3	Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Francis daCosta, 1st Edition, Apress Publications, 2013, ISBN-13: 978-1430257400.
4	Meta products - Building the Internet of Things, WimerHazenberg, Menno Huisman, BIS Publishers, 2012, ISBN: 9789863692515.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INDUSTRY 4.0– SMART MANUFACTURING FOR THE FUTURE (Group H: Global Elective) (Theory)						
Course Code	**:**	**16G7H10**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the importance and role of Smart Manufacturing Systems, IoT and IIoT.
2	Explain importance of automation technologies, sensors, Robotics and Machine vision.
3	Understand application of artificial intelligence and the need for data transformation, handling, storing and security.
4	Understand simulation, predictive and knowledge modeling along with analysis.
5	Learn networking, sustainable technology and factory networks.

Unit-I	**06 Hrs**
Smart Manufacturing and Industry 4.0: Need for Smart Manufacturing, Advantages, Emerging technologies in Smart manufacturing, CAD Architecture surrounding 3D Models (B-rep and CSG), MEMS, Industry 4.0–Interoperability, Information transparency, Technical assistance, Decentralized decision-making, Internet of Things(IoT), Industry Internet of Things (IIoT), Future of Manufacturing industries.	
Unit – II	**09 Hrs**
Manufacturing Automation: Technology intensive manufacturing and cyber-physical systems, Automation using Robotics, Data storage, retrieval, manipulation and presentation; Mechanisms for sensing state and modifying processes, Material handling systems, controlling material movement and machine flow, Mechatronics, Transducers and sensors, Proximity sensors, Biosensors, Acceleration Machine Vision–Flaw detection, Positioning, Identification, Verification and Measurement–Application of Machine Vision in industries.	
Unit –III	**09 Hrs**
Data handling using Embedded Systems: Data transformation–Mathematical functions, Regression, Need for different functions, Data merging–Discrete and Random variables, Transformation languages, Interfacing systems-Microprocessors, Direct memory access, Data transfer schemes and systems, Communication systems–Modulation, Time domain and frequency domain, Industrial Network Data Communications, Data Security Artificial Intelligence – Intelligent systems, Fuzzy logics, Neural networks –Supervised, Unsupervised and Reinforced learning.	
Unit –IV	**06 Hrs**
Simulation, Modeling and Analysis: Simulation - system entities, input variables, performance measures, and Functional relationships, types of simulation. Predictive modeling and simulation tools, Knowledge Modeling –types and technology options, Functional analysis of control systems – Linear and Non-linear, Functional decomposition, Functional sequencing, Information / dataflow, Interface.	
Unit –V	**09 Hrs**
Performance Measures of Smart Manufacturing Systems: Smart manufacturing- Sensing and Perception, Manipulation, Mobility and Autonomy, Factory Networks, Information Modeling and Testing, Performance Measurement and Optimization, Engineering System integration, Production Network integration, Production network data quality, Sustainable Processes and Resources, Integration Infrastructure for Sustainable Manufacturing.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain role and importance of Smart Manufacturing Systems, IoT and IIoT.
CO2	Explain importance of automation technologies, sensors, robotics and machine vision.
CO3	Illustrate the application of artificial intelligence and need for data transformation, handling.
CO4	Explain analytical and simulation for performance study of smart technologies and networks.

Reference Books	
1	Zongwei Luo, Smart Manufacturing Innovation and Transformation: Interconnection And Intelligence, 1st Edition, IGI Global Publications, 2014, ISBN-13: 978-1466658363 ISBN-10: 1466658363
2	Yan Lu. KC Morris, Simon Frechette, Smart Manufacturing Standards, NIST, 1st Edition, 2016, Project report.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
SPACE TECHNOLOGY AND APPLICATIONS (Group H: Global Elective) (Theory)						
Course Code	**:**	**16G7H11**		**CIE**	**:**	**100 Marks**
Credits: L:T:P :S	**:**	**3 : 0 : 0 : 0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**35L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Define the earth environment and its behavior, launching vehicles for satellites and its associated concepts.
2	Analyze satellites in terms of technology, structure and communications.
3	Use satellites for space applications, remote sensing and metrology.
4	Apply the space technology, technology mission and advanced space systems to nation's growth.

UNIT-I	**07 Hrs**
Earth's environment: Atmosphere, ionosphere, Magnetosphere, Van Allen Radiation belts, Interplanetary medium, Solar wind, Solar- Earth Weather Relations. **Launch Vehicles:** Rocketry, Propellants, Propulsion, Combustion, Solid, Liquid and Cryogenic engines, Control and Guidance system, Ion propulsion and Nuclear Propulsion.	
UNIT-II	**07 Hrs**
Satellite Technology: Structural, Mechanical, Thermal, Power control, Telemetry, Telecomm and Quality and Reliability, Payloads, Space simulation. **Satellite structure:** Satellite Communications, Transponders, Satellite antennas.	
UNIT-III	**07 Hrs**
Satellite Communications: LEO, MEO and GEO orbits, Altitude and orbit controls, Multiple Access Techniques. **Space applications:** Telephony, V-SAT, DBS system, Satellite Radio and TV, Tele-Education, Tele-medicine, Satellite navigation, GPS.	
UNIT-IV	**07 Hrs**
Remote Sensing: Visual bands, Agricultural, Crop vegetation, Forestry, water Resources, Land use, Land mapping, geology, Urban development resource Management, and image processing techniques. **Metrology:** Weather forecast (Long term and Short term), weather modelling, Cyclone predictions, Disaster and flood warning, rainfall predictions using satellites.	
UNIT-V	**07Hrs**
Satellite payloads: Technology missions, deep space planetary missions, Lunar missions, zero gravity experiments, space biology and International space Missions. **Advanced space systems:** Remote sensing cameras, planetary payloads, space shuttle, space station, Inter-space communication systems.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain different types of satellites, orbit and associated subsystems.
CO2	Apply the basics of launching vehicles, satellites and sub systems for space applications.
CO3	Analyze the applications of satellite in the area of communication, remote sensing, metrology etc.,
CO4	Study technology trends, satellite missions and advanced space systems.

Reference Books	
1	Atmosphere, weather and climate, R G Barry, Routledge publications, 2009, ISBN- 10 :0415465702.
2	Fundamentals of Satellite Communication, K N Raja Rao, PHI, 2012, ISBN:9788120324015.
3	Satellite Communication, Timothy pratt, John Wiley, 1986 ISBN: 978-0- 471- 37007 -9, ISBN 10: 047137007X.
4	Remote sensing and applications, B C Panda, VIVA books Pvt. Ltd., 2009, ISBN: 108176496308.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	---	---	---	---	---	---	---	---	1	---
CO2	2	2	1	1	---	---	---	---	---	---	1	---
CO3	2	2	1	---	---	---	---	---	---	---	1	---
CO4	2	2	1	---	---	---	---	---	---	---	1	---

High-3: Medium-2: Low-1

Semester: VII						
ADVANCED LINEAR ALGEBRA **(Group G: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H12**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Adequate exposure to learn the fundamental concepts to model a system of linear equations and to obtain the solution of system of linear equations.
2	Analyze and extend the structure of vector spaces, linear transformations, Symmetric matrices, quadratic forms required in applications of Business, Science and Engineering.
3	Apply the concept of Eigenvalues to study differential equations and dynamical systems. Apply the concept of Orthogonality to examine some of the least-squares problems.
4	Apply Linear Programming to Network problems and Game theory.

Unit-I	**07 Hrs**
System of linear equations: Matrices and system of linear equations, Geometry of linear equations, Linear models in Business, Science and Engineering-Input-Output model in Economics, Balancing chemical equations and Electrical networks.	
Unit – II	**09 Hrs**
Vector spaces and linear transformations: Revision of Vector Spaces, Subspaces, Linear independence, Basis, Dimension and Change of basis. Applications to Difference equations, Markov chains. Intersection, Sum, Product of spaces and Tensor product of two vector spaces. Introduction to Linear transformations, Geometrical interpretations in 2-dimensions and 3-dimensions.	
Unit –III	**09 Hrs**
Orthogonality, Eigen values and Eigen vectors: Orthogonality, Inner product spaces, Applications to Weighted least-squares and Fourier series, Fast Fourier transform. Eigen values and Eigen vectors, Applications to Differential equations, Discrete dynamical systems.	
Unit –IV	**07 Hrs**
Symmetric matrices and quadratic forms: Introduction to symmetric matrices, Quadratic forms, Test for Positive definiteness, Constrained Optimization, Singular Value Decomposition. Applications to image processing.	
Unit –V	**07 Hrs**
Linear programming and game theory: A Geometrical introduction to Linear programming, Simplex method and its geometrical meaning, Network models-Max flow-min cut theorem, Payoff matrix and Matrix games.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify and interpret the fundamental concepts of linear equations, vector spaces, linear transformations, Orthogonality, Eigen values, symmetric matrices, quadratic forms, linear programming and game theory.
CO2	Apply the knowledge and skills of Linear algebra to solve linear equations, difference and differential equations, constrained optimization problems, linear programming problems and related problems.
CO3	Analyze the input-output models, Markov chains, discrete dynamical systems, singular value decomposition, network models and related problems.
CO4	Using the overall mathematical knowledge of Linear Algebra to solve problems arising in practical situations.

Reference Books	
1	David C Lay; Linear Algebra and Its Applications; Pearson Education; III Edition; 2003; ISBN: 978-81-775-8333-5.
2	Gareth Williams; Linear Algebra with Applications; 6th edition; 2008; Narosa publications; ISBN: 978-81-7319-981-3.
3	Gilbert Strang; Linear Algebra and Its Applications; 4th Edition; Cengage Learning India Edition; 2006; ISBN: 81-315-0172-8.
4	Howard Anton and Chris Rorres; Elementary Linear Algebra Applications Version; Wiley Global Education; 11th Edition; 2013; ISBN: 9781118879160.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 60 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2: Low-1

Semester: VII						
ADVANCED LINEAR ALGEBRA **(Group G: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H12**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Adequate exposure to learn the fundamental concepts to model a system of linear equations and to obtain the solution of system of linear equations.
2	Analyze and extend the structure of vector spaces, linear transformations, Symmetric matrices, quadratic forms required in applications of Business, Science and Engineering.
3	Apply the concept of Eigen values to study differential equations and dynamical systems. Apply the concept of Orthogonality to examine some of the least-squares problems.
4	Apply Linear Programming to Network problems and Game theory.

Unit-I	**07 Hrs**
System of linear equations: Matrices and system of linear equations, Geometry of linear equations, Linear models in Business, Science and Engineering-Input-Output model in Economics, Balancing chemical equations and Electrical networks.	
Unit – II	**09 Hrs**
Vector spaces and linear transformations: Revision of Vector Spaces, Subspaces, Linear independence, Basis, Dimension and Change of basis. Applications to Difference equations, Markov chains. Intersection, Sum, Product of spaces and Tensor product of two vector spaces. Introduction to Linear transformations, Geometrical interpretations in 2-dimensions and 3-dimensions.	
Unit –III	**09 Hrs**
Orthogonality, Eigen values and Eigen vectors: Orthogonality, Inner product spaces, Applications to Weighted least-squares and Fourier series, Fast Fourier transform. Eigen values and Eigen vectors, Applications to Differential equations, Discrete dynamical systems.	
Unit –IV	**07 Hrs**
Symmetric matrices and quadratic forms: Introduction to symmetric matrices, Quadratic forms, Test for Positive definiteness, Constrained Optimization, Singular Value Decomposition. Applications to image processing.	
Unit –V	**07 Hrs**
Linear programming and game theory: A Geometrical introduction to Linear programming, Simplex method and its geometrical meaning, Network models-Max flow-min cut theorem, Payoff matrix and Matrix games.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify and interpret the fundamental concepts of linear equations, vector spaces, linear transformations, Orthogonality, Eigen values, symmetric matrices, quadratic forms, linear programming and game theory.
CO2	Apply the knowledge and skills of Linear algebra to solve linear equations, difference and differential equations, constrained optimization problems, linear programming problems and related problems.
CO3	Analyze the input-output models, Markov chains, discrete dynamical systems, singular value decomposition, network models and related problems.
CO4	Using the overall mathematical knowledge of Linear Algebra to solve problems arising in practical situations.

Reference Books	
1	David C Lay; Linear Algebra and Its Applications; Pearson Education; 3rd Edition; 2003; ISBN: 978-81-775-8333-5.
2	Gareth Williams; Linear Algebra with Applications; 6th edition; 2008; Narosa publications; ISBN: 978-81-7319-981-3.
3	Gilbert Strang; Linear Algebra and Its Applications; 4th Edition; Cengage Learning India Edition; 2006; ISBN: 81-315-0172-8.
4	Howard Anton and Chris Rorres; Elementary Linear Algebra Applications Version; Wiley Global Education; 11th Edition; 2013; ISBN: 9781118879160.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 60 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2: Low-1

Semester: VII						
THIN FILM NANOTECHNOLOGY **(Group G: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H13**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the importance of vacuum in thin film fabrication.
2	Acquire the knowledge of thin film preparation by various techniques.
3	Analyze the properties of thin films using different characterization methods.
4	Optimize the process parameter and property dependence.
5	Apply the knowledge for developing thin film devices.

Unit-I	**08 Hrs**
Vacuum Technology: Basics of Vacuum - Principles of different vacuum pumps: Rotary, Roots, Diffusion, Turbo molecular and Cryogenic pumps; Measurement of vacuum - Concept of Capacitance Manometer, Pirani and Penning gauges - Vacuum Systems & Applications.	
Unit – II	**08 Hrs**
Methods of thin film preparation: Physical Vapor Deposition (PVD) Techniques**:** *Evaporation*: Thermal evaporation, Electron beam evaporation, Laser ablation, and Cathode arc deposition. *Sputtering*: DC sputtering, RF Sputtering, Magnetron sputtering, Reactive Sputtering, and Ion beam sputtering. Chemical Vapor Deposition (CVD) Techniques**:** Conventional CVD, Plasma Enhance CVD (PECVD) and Atomic layer deposition (ALD). Other Methods: Spin coating and Spray Pyrolysis.	
Unit –III	**07 Hrs**
Surface Modification and Growth of Thin Films: Surface preparation & Engineering for Thin film growth: Cleaning, Modification, Masking & Patterning, Base Coats and Top Coats. Thin Film growth: Sequence of thin film growth, Defects and impurities, Effect of Deposition Parameters on film growth.	
Unit –IV	**08 Hrs**
Properties and Characterization of Thin Films: Film thickness (Quartz crystal thickness monitor and Stylus Profiler), Film Adhesion (Tape, Cross-hatch test, and Humidity methods), Surface morphology and topography (SEM and AFM), Film composition (X-ray Photoelectron Spectroscopy), Film structure (X-ray diffraction and Raman studies), Electrical characterization (Four Probe and Semiconductor Analyzer) and Optical characterization (Spectrophotometer).	
Unit –V	**08 Hrs**
Thin Film Applications: ▪ Electrodes: Deposition of a Metal film, Ex: Aluminum. ▪ Transparent conducting oxides (TCO) – Preparation and Optimization of a semiconducting film, Ex: ZnO. ▪ Optimization of a dielectric film, Ex: Al_2O_3 or Si_3N_4. **Thin Film Devices**: • Thin Film Transistors (TFT), • Thin Film Sensors • Thin Film Capacitors • Thin film Solar Cells, • Thin film Solar Absorbers ▪ Diamond-like carbon (DLC) coating ▪ EMI Shielding coatings ▪ Hard coatings ▪ Coatings on Plastics/Polymers.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the importance of vacuum technology for thin film growth.
CO2	Prepare various kinds of thin films using different deposition techniques.
CO3	Characterize the deposited films for various properties.
CO4	Fabricate thin film-based devices.

Reference Books	
1.	Vacuum Technology, A. Roth, Elsevier, 3rd Edition, 1976, ISBN: 9780444880109, 9780444598745.
2.	Thin Film Phenomenon, K.L. Chopra, McGraw-Hill, 1st Edition, 1969, ISBN: 0070107998, 978-0070107991.
3.	Materials Science of Thin Films, Milton Ohring, Elsevier, 2nd Edition, 2001, ISBN: 9780125249751.
4.	Thin-Film Deposition: Principles and Practice, Donald Smith, McGraw-Hill, 1st Edition, 1995, ISBN: 0070585024, 9780070585027

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 60 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1			1									2
CO2				2								2
CO3					2							2
CO4			2	2	2		2		2	2		2

High-3: Medium-2: Low-1

Semester: VII						
ENGINEERING MATERIALS FOR ADVANCED TECHNOLOGY **(Group H: Global Elective)** **(Theory)**						
Course Code:	**:**	**16G7H14**		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**39L**		**SEE Duration**	**:**	**3.00Hours**

Course Learning Objectives: The students will be able to

1	Aapply the basic concepts of Chemistry to develop futuristic materials for high-tech applications in the area of Engineering.
2	Impart sound knowledge in the different fields of material chemistry so as to apply it to the problems in engineering field.
3	Develop analytical capabilities of students so that they can characterize, transform and use materials in engineering and apply knowledge gained in solving related engineering problems.

UNIT-I	**08 Hrs**

Coating and packaging materials

Surface Coating materials: Synthesis and applications of Polymer coating materials: Teflon, Silicone films Polyvinyl chloride & its copolymers, Poly vinyl acetate, Poly ethylene-HDPE, LDPE, Polyurethane. Properties required in a pigment and extenders.

Inorganic pigments-titanium dioxide, zinc oxide, carbon black, chromate pigments, chrome green, ultramarine blue, iron blue, cadmium red.

Corrosion inhibiting pigments: zinc phosphate, zinc and barium chromate pigments, ceramic pigments, metal flake pigments, extenders.

Developments in new polymers such as dendrimers, biopoplymers & biodegradable polymers.

Packaging materials: Food products: Cellulosic and Polymeric packaging materials and their properties – including barrier properties, strength properties, optical properties. Glass, aluminium, tin, paper, plastics, composites.

Pharmaceutical products: Injectibles and tablet packaging materials.

UNIT-II	**07 Hrs**

Adhesives: Introduction-Classification of Adhesives-Natural adhesives, synthetic adhesives-drying adhesives, pressure sensitive adhesives, contact adhesives, hot adhesives. One part adhesives, multi part adhesives. Adhesive Action. Development of Adhesive strength- Physical factors influencing Adhesive Action-surface tension, surface smoothness, thickness of adhesive film, elasticity and tensile strength. Chemical Factors Influencing Adhesive action - presence of polar groups, degree of polymerization, complexity of the adhesive molecules, effect of pH. Adhesive action- specific adhesive action, mechanical adhesive action, fusion adhesion. Development of adhesive strength- adsorption theory and diffusion theory. Preparation, curing and bonding Processes by adhesives-with reference to Epoxy, phenolics, Silicone, Polyurethane, Acrylic adhesives, Poly vinyl alcohol, Polyvinyl acetate.

UNIT-III	**08 Hrs**

Optical fibre materials: Fiber Optics, Advantages of optical fiber communication over analog communication, Classification based on refractive index of the core- step index and graded index optical fibres, Classification based on core radius-single mode and multimode optical fibres, Fibre fabrication.- Methods to manufacture optical glass fibres. Double crucible method and preform methods. Manufacture of perform- Chemical Vapour Deposition (CVD), Modified vapour deposition (MCVD) Plasma activated vapour deposition (PCVD), Outside vapour deposition (OVD)-Vapour-phase axial deposition (VAD). Drawing the fibres from perform, coating and jacketing process.

Ion exchange resins and membranes: Ion exchange resins-Introduction, Types, physical properties, chemical properties-capacity, swelling, kinetics, stability, ion exchange equilibrium, regeneration. Applications of ion exchange resins-softening of water, demineralization of water, advantages and disadvantages of ion exchange resins-calcium sulphate fouling, iron fouling, adsorption of organic matter, bacterial contamination. Ion exchange membranes, Types, Classification, Fabrication of ion exchange cottons- anion exchange cotton and cation exchange cotton. Application of ion exchange membranes in

purification of water by electro dialysis method.	
UNIT-IV	**08 Hrs**
Spectroscopic Characterization of materials: Electromagnetic radiation, interaction of materials with electromagnetic radiation. UV- visible spectrophotometry: Introduction-Electronic transitions- factors influencing position and intensity of absorption bands-absorption spectra of dienes, polyene and α,β-unsaturated carbonyl compounds, Working of UV-Vis spectrophotometer, Theoretical calculation of λ_{max} by using Woodward-Fieser rules- for cyclic and α,β-unsaturated carbonyl compounds. IR Spectroscopy: Introduction, principle, molecular vibrations, vibrational frequency, number of fundamental vibrations, factors influencing fundamental vibrations, instrumentation of IR spectrophotometer, sampling techniques and application of IR spectroscopy in characterization of functional groups.	
UNIT-V	**08 Hrs**
NMR spectroscopy: H^1 NMR Spectroscopy: Basic concepts- relaxation process. NMR spectrometer-FT NMR-Solvents used in NMR, internal standards-Chemical equivalence -Integrals and Integrations-chemical shift-Factors affecting chemical shifts- shielding and deshielding effects – chemical and magnetic equivalent –magnetic anisotropy-spin-spin splitting rules- Application of NMR on various compounds such as alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers, amines, aldehydes, ketones, carboxylic acids, esters, amides & mono substituted aromatic compounds. Problems on prediction of structure of compounds.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify sustainable engineering materials and understand their properties.
CO2	Apply the basic concepts of chemistry to develop futuristic materials for high-tech applications in different areas of engineering.
CO3	Analyze and evaluate the specific application of materials.
CO4	Design the route for synthesis of material and its characterization.

Reference Books	
1.	Materials Science, G.K.Narula, K.S.Narula & V.K.Gupta, 38th Edtion, 2015, Tata McGraw-Hill Publishing Company Limited, ISBN: 978-0-07-451796-3.
2.	Solar Lighting, Ramachandra Pode and Boucar Diouf, 2011, Springer e-book, ISBN: 978-1-44-712133-6 (Print) 978-1-44-712134-3 (Online),
3.	Spectroscopy of organic compounds, P.S.Kalsi, 6th Edition, 2013, New Age International (P) ltd, publisher, ISBN: 978-1-22-415438-6.
4.	Food Packaging Materials, Mahadeviah M & Gowramma RV, 6th Edition, 1996, Tata McGraw Hill Publishing Company Ltd, ISBN :746-2-23-82 9780-0.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
APPLIED PSYCHOLOGY FOR ENGINEERS **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H15**		**CIE**	**:**	**100**
Credits: L:T:P	**:**	**3:0:0**		**SEE**	**:**	**100**
Total Hours	**:**	**35**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives: The students will be able to

1	To appreciate human behavior and human mind in the context of learner's immediate society and environment.
2	To understand the importance of lifelong learning and personal flexibility to sustain personal and Professional development as the nature of work evolves.
3	To provide students with knowledge and skills for building firm foundation for the suitable engineering professions.
4	To prepare students to function as effective Engineering Psychologists in an Industrial, Governmental or consulting organization.
5	To enable students to use psychological knowledge, skills, and values in occupational pursuits in a variety of settings that meet personal goals and societal needs.

Unit – I	**7 Hrs**
Introduction to Psychology: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method.	
Unit - II	**7 Hrs**
Intelligence and Aptitude: Concept and definition of Intelligence and Aptitude, Nature of Intelligence. Theories of Intelligence – Spearman, Thurston, Guilford Vernon. Characteristics of Intelligence tests, Types of tests. Measurement of Intelligence and Aptitude, Concept of IQ, Measurement of Multiple Intelligence – Fluid and Crystallized Intelligence.	
Unit – III	**7 Hrs**
Personality: Concept and definition of personality, Approaches of personality- psychoanalytical, Socio- Cultural, Interpersonal and developmental, Humanistic, Behaviorist, Trait and type approaches. Assessment of Personality: Self- report measures of Personality, Questionnaires, Rating Scales and Projective techniques, its Characteristics, advantages & limitations, examples. Behavioral Assessment. Psychological Stress: a. Stress- Definition, Symptoms of Stress, Extreme products of stress v s Burnout, Work Place Trauma. Causes of Stress – Job related causes of stress. Sources of Frustration, Stress and Job Performance, Stress Vulnerability-Stress threshold, perceived control.	
Unit – IV	**7 Hrs**
Application of Psychology in Working Environment: The present scenario of information technology, the role of psychologist in the organization, Selection and Training of Psychology Professionals to work in the field of Information Technology. Distance learning, Psychological consequences of recent developments in Information Technology. Type A and Type B Psychological Counseling - Need for Counseling, Types – Directed, Non- Directed, Participative Counseling.	
Unit – V	**7 Hrs**
Learning: Definition, Conditioning – Classical Conditioning, Basics of Classical Conditioning (Pavlov), the process of Extinction, Discrimination and Generalization. Operant Conditioning (Skinner expt). The basics of operant conditioning, Schedules of reinforcement. Cognitive – Social approaches to learning – Latent Learning, Observational Learning, Trial and Error Method, Insightful Learning.	
Experimental Psychology (Practicals)- Self Study 2 Hrs /Week	
1.Bhatia's Battery of Performance and intelligence test. 2.Multidimensional Assessment of Personality . 3.David's Battery of Differential Abilities (Aptitude test).	

4.Bilateral Transfer of Training Mirror drawing apparatus with Electronic Digital Reset Error Counter (Performance). 5. Student Stress Scale.	
Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the basic theories, principles, and concepts of applied psychology as they relate to behaviors and mental processes.
CO2	Define learning and compare and contrast the factors that cognitive, behavioral, and Humanistic theorists believe influence the learning process.
CO3	Develop understanding of psychological attributes such as intelligence, aptitude, creativity, resulting in their enhancement and apply effective strategies for self-management and self-improvement.
CO4	Apply the theories into their own and others' lives in order to better understand their personalities and experiences.
CO5	Understand the application of psychology in engineering and technology and develop a route to accomplish goals in their work environment.
Reference Books:	
1. Understanding Psychology Feldman R. S, IV edition, (1996) McGraw Hill Indi.	
2. Psychology Robert A. Baron, III edition (1995) Prentice Hall India.	
3. Organizational Behaviour , Stephen P Robbins Pearson Education Publications, 13th Edition, ISBN – 81-317 – 1132 .	
4. Organisational Behaviour : Human Behaviour at Work ,John W.Newstrem and Keith Davis. Tata McGraw Hill India, 10th Edition, ISBN 0-07-046504-	
5. Psychology-themes and variations , Wayne Weiten, IV edition, Brooks / Cole Publishing Co.	
Scheme of Continuous Internal Evaluation (CIE):	
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimu three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The nu of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum o marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Pr is 10. **Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**	
Scheme of Semester End Examination (SEE):	
SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.	

VII Semester						
FOUNDATIONAL COURSE ON ENTREPRENEURSHIP (Group H: Global Elective) (Theory)						
Course Code	**:**	**16G7H16**		**CIE Marks**	**:**	**100**
Credits: L:T:P:S	**:**	**3:0:0:0**		**SEE Marks**	**:**	**100**
Total Hours	**:**	**36L**		**SEE Duration**	**:**	**03 Hours**

Course Learning Objectives:

1	To make participants self-discover their innate flow, entrepreneurial style, and identify problems worth solving thereby becoming entrepreneurs.
2	To handhold participants on lean methodology to craft value proposition and get ready with lean canvas.
3	To create solution demo by conducting customer interviews and finding problem-solution fit for building Minimum Viable Product (MVP).
4	To make participants understand cost structure, pricing, revenue types and importance of adopting shared leadership to build good team.
5	To help participants build a strong brand and identify various sales channels for their products and services.
6	To take participants through basics of business regulations and other legal terms along-with understanding of Intellectual Property Rights.

Unit-I	**07 Hrs**
Self Discovery and Opportunity Discovery: Finding the Flow; Effectuation; Identifying the Effectuation principles used in activities; Identifying Problem Worth Solving; Design Thinking; Brainstorming; Presenting the Identified problems; Identifying the Entrepreneurial Style.	
Unit – II	**07 Hrs**
Customer, Solution and Lean Methodology: Customers and Markets; Segmentation and Targeting; Identifying Jobs, Pains, and Gains and Early Adopters; Crafting Value Proposition Canvas (VPC); Presenting VPC; Basics of Business Model and Lean Approach; Sketching the Lean Canvas; Risks and Assumptions; Presenting Lean Canvas.	
Unit – III	**07 Hrs**
Problem-Solution Fit and Building MVP: Blue Ocean Strategy - Plotting the Strategy Canvas; Four Action Framework: Eliminate-Reduce-Raise-Create Grid of Blue Ocean Strategy; Building Solution Demo and Conducting Solution Interviews; Problem-Solution Fit; Building MVP; Product-Market Fit; Presenting MVP.	
Unit – IV	**06 Hrs**
Financial Planning & Team Building: Cost Structure - Estimating Costs; Revenues and Pricing: Revenue Streams, Revenue Types, Identifying Secondary Revenue Streams, Estimating Revenue and Price; Profitability Checks; Bootstrapping and Initial Financing; Practising Pitch; Shared Leadership; Hiring and Fitment, Team Role and Responsibilities.	
Unit – V	**09 Hrs**
Marketing, Sales, Regulations and Intellectual Property: Positioning and Branding; Channels; Sales Planning; Project Management; Basics of Business Regulations; How to Get Help to Get Started; Patents, Trademark, Licensing, Contracts; Common Legal mistakes, Types of Permits, Tax Registration Documents, Compliance; Infringement and Remedies, Ownership and Transfer.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Showcase the ability to discern distinct entrepreneurial traits.
CO2	Know the parameters to assess opportunities and constraints for new business ideas.
CO3	Understand the systematic process to select and screen a business idea.
CO4	design strategies for successful implementation of ideas.
CO5	Create Business Model and develop Minimum Viable Product.

Reference Books	
1	Running Lean: Iterate from Plan A to a Plan That Works. O'Reilly Media, Maurya, A., 2012.
2	Entrepreneurship.Roy, R., 2012. Oxford University Press
3	Intellectual Property Law in India. Gupta, T. S., 2011. Kluwer Law International
4	Flow: The Psychology of Optimal Experience. Czikszentmihalyi, M., 2008. Harper Perennial Modern Classics
5	Effectuation: Elements of Entrepreneurial Expertise. Sarasvathy, S. D., 2009. Edward Elgar Publishing Ltd.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)- (Needs to be discussed)

SEE for 100 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy lev

Semester: VII						
UNMANNED AERIAL VEHICLES **(Group H: Global Elective)** **(Theory)**						
Course Code	**:**	**16G7H17**		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	**3:0:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**36L**		**SEE Duration:**	**:**	**3Hrs**

Course Learning Objectives: The students will be able to	
1	Get an overview of the history of UAV systems.
2	Understand the importance of aerodynamics, propulsion, structures and avionics in the design of UAV.
3	Demonstrate ability to address the various mission payloads - on-board & off-board, propulsion systems, integration with manned systems.
4	Assess the performance and airworthiness of the designed UAV.

Unit-I	**06 Hrs**
Introduction to Flight Vehicles: History of Flight Vehicles and UAVs, Classifications, Woking principles of flight vehicle. **Introduction to Unmanned Aircraft Systems:** Types of UAVs, configurations and their advantages disadvantages, System Composition, Applications of UAVs, Characteristics of Aircraft.	
Unit – II	**07 Hrs**
Design of UAV Systems: Governing aspects: Aerodynamics, b. Propulsion, C. structure, d. Controls **Aerodynamics:** Introduction basic Aerodynamics, lift, drag, Aerofoils, wing area optimization. **Propulsion:** Introduction to propulsion system in UAV, Propulsion system for fixed wing UAV and VTOL (Vertical take-off and landing) UAV, Advanced propulsion systems, fuel cells, generators based systems.	
Unit -III	**07Hrs**
Structures of UAV: Mechanic loading, basics of types of load calculation and structural engineering, Material used for UAV (general introduction), FRP and methods of usage in UAV, Testing of FRP specimens for UAV, selection criteria for structure, Types of structural elements used in UAV their significance and characteristics, Methods of manufacturing UAV structure.	
Unit -IV	**07 Hrs**
Controls, Avionics, Hardware, Communication, Payloads: Basics of control system and Systems for control system in UAV, PID control, simulation introduction to Hardware in loop system (HILS), Avionics: Autopilot(AP) – architecture of AP, sensors, actuators, power supply, integration, installation, configuration, and testing. **Hardware, Communication:** Electronics Hardware in UAV, Communication methods, communication antenna and their significance. **Payloads:** Payload types and their applications	
Unit -V	**09 Hrs**
Design of UAV Systems: Fixed wing UAV and Rotary wing UAV (VTOL), Task specific, activity based exercise	

Course Outcomes: At the end of this course the student will be able to :	
CO1	Appraise the evolution of UAVs and understand the current potential benefits of UAVs.
CO2	Apply the principles of Aerospace Engineering in design and development of UAVs.
CO3	Determine and evaluate the performance of UAV designed for various Missions and applications.
CO4	Assess the performance and airworthiness of the designed UAV.

Reference Books	
1	Unmanned Aircraft Systems UAV design, development and deployment, Reg Austin, 1st Edition, 2010, Wiley, ISBN 9780470058190.
2	Flight Stability and Automatic Control, Robert C. Nelson, 2nd Edition, October 1, 1997, McGraw-Hill, Inc, ISBN 978-0070462731.
3	Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy, Kimon P. Valavanis, 1st Edition,2007, Springer ISBN 9781402061141.
4	Introduction to UAV Systems, Paul G Fahlstrom, Thomas J Gleason, 4th Edition, 2012, Wiley, ISBN: 978-1-119-97866-4.
5	Design of Unmanned Air Vehicle Systems,Dr. Armand J. Chaput, 3rd Edition, 2001, Lockheed Martin Aeronautics Company, ISBN: 978-1-60086-843-6.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	3	2	2				1
CO2	2	3	3	3	1	1	1	1				2
CO3	1		3	3								2
CO4	3	3	3	3		2	1	2				2

High-3: Medium-2: Low-1

Semester: VIII						
Major Project						
Course Code	**:**	**16TE81**		**CIE**	**:**	**100 Marks**
Credits: L:T:P :S	**:**	**0:0:16:0**		**SEE**	**:**	**100 Marks**
Hrs/Week	**:**	**32**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
2	Acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific
3	Acquire collaborative skills through working in a team to achieve common goals.
4	Self-learn, reflect on their learning and take appropriate action to improve it.
5	Prepare schedules and budgets and keep track of the progress and expenditure.

Major Project Guidelines:

1. The project topic, title and synopsis have to be finalized and submitted to their respective internal guide(s) before the beginning of the 8th semester.
2. The detailed Synopsis (approved by the department ***Project Review Committee***) has to be submitted during the 1st week after the commencement of 8th semester.

Batch Formation:

- Students are free to choose their project partners from within the programme or any other programme.
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house / Industry / R & D Institution.
- ***The project work is to be carried out by a team of two to four students , in exceptional cases where a student is placed in a company and offered an internship through the competitive process or student is selected for internship at national or international level through competitive process*****,** the student can work independently.
- ***The students are allowed to do either a project for full 5 days in the industry or full 5 days in the college.***
- ***In case the project work is carried out outside Bengaluru, such students must be available during Project Evaluation process scheduled by the respective departments and they must also interact with their guide regularly through Email / Webinar / Skype etc.***

Project Topic Selection:

The topics of the project work must be in the ***field of respective program areas or in line with CoE's(Centre of Excellence) identified by the college*** or **List of project areas as given by industry/Faculty. The projects as far as possible should have societal relevance with focus on sustainability.**

Project Evaluation:

- Continuous monitoring of project work will be carried out and cumulative evaluation will be done.
- The students are required to meet their internal guides once in a week to report their progress in project work.
- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Internal Guide regularly.
- In case of ***Industry project***, during the course of project work, the internal guides will have continuous interaction with external guides and will visit the industry at least twice during the project period.
- For CIE assessment the project groups must give a final seminar with the draft copy of the project report.

- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.
- Before the final evaluations the project group is required to produce a No dues certificate from Industry, Central Library and Department.

Course Outcomes of Major Project:	
1	Apply knowledge of mathematics, science and engineering to solve respective engineering domain problems.
2	Design, develop, present and document innovative/multidisciplinary modules for a complete engineering system.
3	Use modern engineering tools, software and equipment to solve problem and engage in life-long learning to follow technological developments.
4	Function effectively as an individual, or leader in diverse teams, with the understanding of professional ethics and responsibilities.

CIE Assessment:

The following are the weightings given for the various stages of the project.

1. Selection of the topic and formulation of objectives 10%
2. Design and Development of Project methodology 25%
3. Execution of Project 25%
4. Presentation, Demonstration and Results Discussion 30%
5. Report Writing & Publication 10%

SEE Assessment:

The following are the weightages given during Viva Examination.

1. Written presentation of synopsis 10%
2. Presentation/Demonstration of the project 30%
3. Methodology and Experimental Results & Discussion 30%
4. Report 10%
5. Viva Voce 20%

Calendar of Events for the Project Work:

Week	Event
Beginning of 7th Semester	Formation of group and approval by the department committee.
7th Semester	Problem selection and literature survey
Last two weeks of 7th Semester	Finalization of project and guide allotment
II Week of 8th Semester	Synopsis submission and preliminary seminar
III Week	First visit of the internal guides to industry (In case of project being carried out in industry)
III to VI Week	Design and development of project methodology
VII to IX Week	Implementation of the project
X Week	Submission of draft copy of the project report

XI and XII Week	Second visit by guide to industry for demonstration. Final seminar by Department project Committee and guide for internal assessment. Finalization of CIE.

Evaluation Scheme for CIE and SEE

Scheme of Evaluation for CIE		**Scheme of Evaluation for SEE**	
Particulars	**%Marks**	**Particulars**	**%Marks**
Project Evaluation I	10%	Project Synopsis (Initial Write up)	10%
Project Evaluation II	25%	Project Demo / Presentation	30%
Project Evaluation III	25%	Methodology and Results Discussion	30%
Project Evaluation Phase-IV (Submission of Draft Project Report for Verification)	30%	Project Work Report	10%
Project Evaluation Phase-V (Project Final Internal Evaluation)	10%	Viva-voce	20%
Total	**100**	**Total**	**100**

Semester: VIII						
TECHNICAL SEMINAR						
Course Code	**:**	**16TE82**		**CIE**	**:**	**50 Marks**
Credits: L:T:P :S	**:**	**0:0:2:0**		**SEE**	**:**	**00 Marks**
Hrs/Week	**:**	**4**		**SEE Duration**	**:**	**NA**

Course Learning Objectives: The students will be able to	
1	Recognize recent developments in specific program and in multidisciplinary fields.
2	Summarize the recent technologies and inculcate the skills for literature survey.
3	Demonstrate good presentation skills.
4	Plan and improve the Technical Report writing skills.
5	Support Group discussion and Team work.

General Guidelines for the Seminar

1. The seminar has to be presented by individual student.
2. The topic of the seminar should be from current thrust area along with consultation with the guide.
3. The topic can be based on standard papers (like IEEE/ACM/CSI etc.) in the thrust area for the selected topic.
4. Presenting/publishing this paper in conference/ Journal will be given weightage in CIE.
5. The student needs to submit both hard & soft copy of the seminar report.
6. **As Outcome of Technical Seminar, each student has to prepare a technical paper out of seminar topic.**

Course Outcomes of Technical Seminar:	
1	Communicate effectively on complex engineering problems and demonstrate contextual knowledge to assess societal and environmental contexts.
2	Identify, formulate, review research literature, analyze and Design solutions for complex engineering problems using appropriate techniques with effective documentation.
3	Analyze, interpret and synthesize the information to provide valid conclusions with innovative ideas and ethical principles.
4	Apply the knowledge of engineering specialization to suggest solutions to complex engineering problems and recognize the need for technological changes.

Evaluation of CIE Marks:

1. Relevance of the topic 10%
2. Literature Survey 10%
3. Presentation 40%
4. Report 20%
5. Paper Publication 20%

Semester: VIII						
INNOVATION & SOCIAL SKILLS						
Course Code	**:**	**16 HS83**		**CIE**	**:**	**NA**
Credits: L:T:P :S	**:**	**0:0:1:0**		**SEE**	**:**	**NA**
Hrs/Week	**:**	**2**		**SEE Duration**	**:**	**NA**

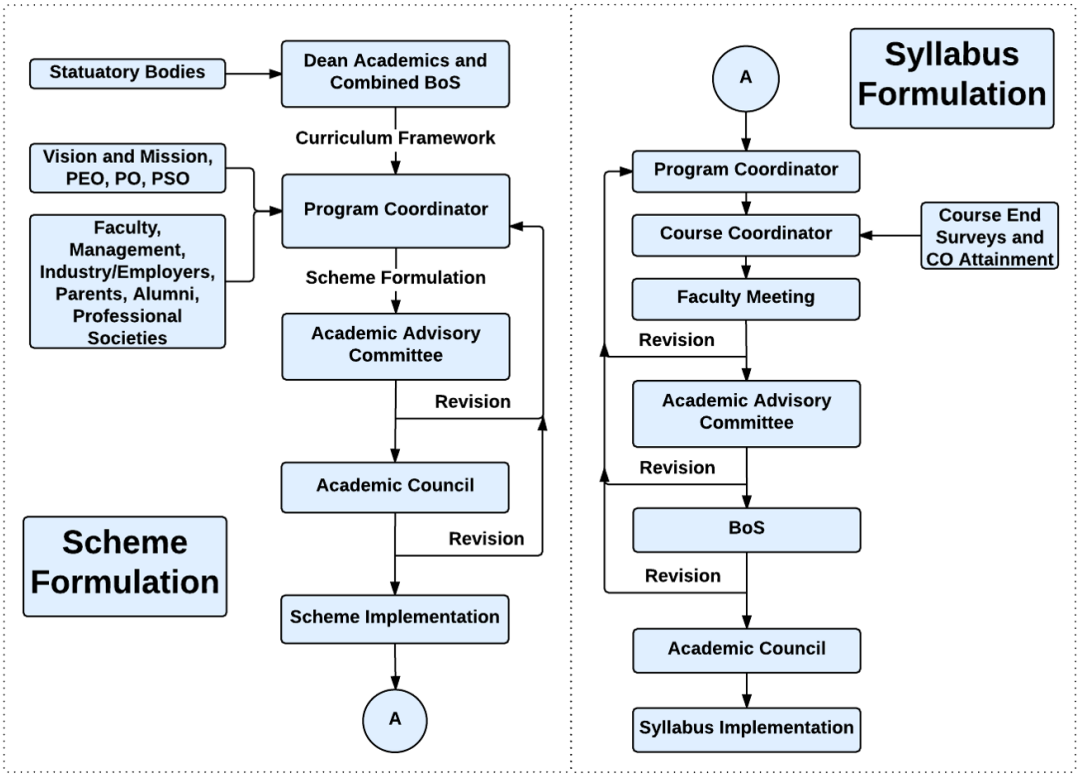
Course Learning Objectives: The students will be able to	
1	To provide a platform for the students to exhibit their organizational capabilities, team building, ethical values and extra mural abilities.
2	To encourage to carryout innovative ideas and projects.
3	Take part in societal and community building activities.
4	Make self-learning, ethics and lifelong learning a motto.

Guidelines

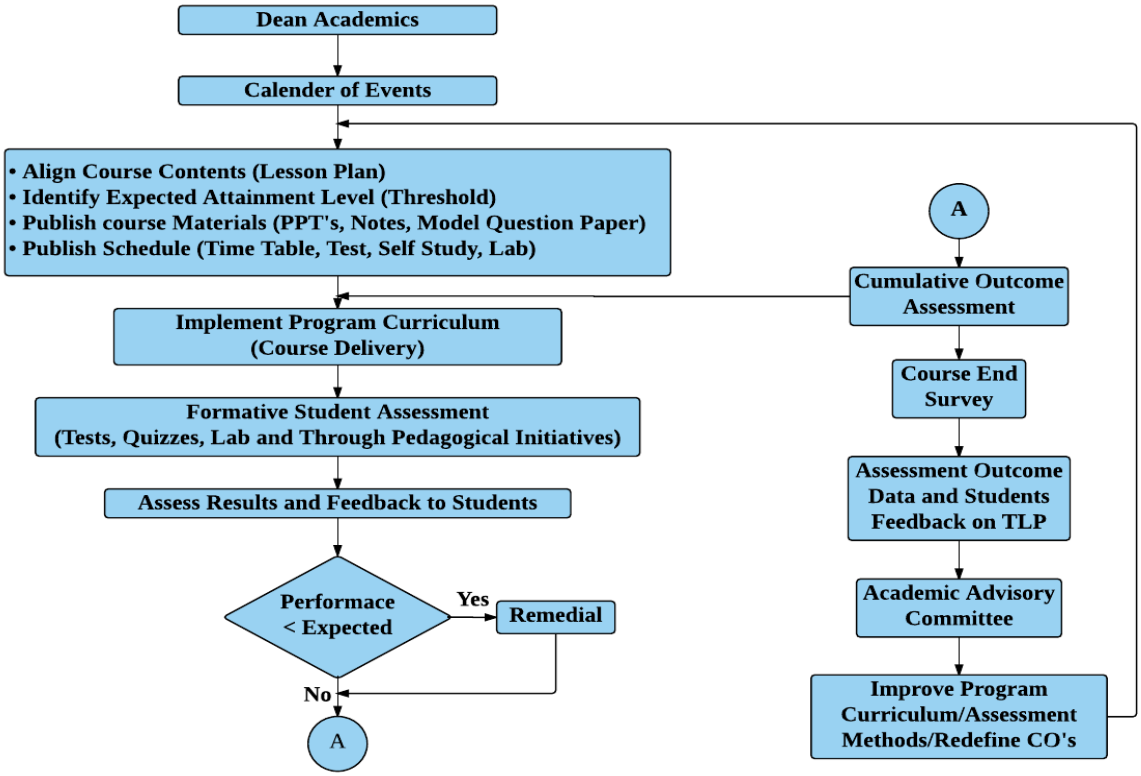
1. The HSS will be evaluated individually based on the broad parameters which include the progress made by student during 3rd& 4th year in innovative projects, Seminar, Paper Presentation, Field activity & other Co-curricular activities.
2. Students shall submit a report and documents as a proof his/her achievements.

Course Outcomes of Innovation & Social Skills:	
1	Apply the knowledge and skills for solving societal issues
2	Plan to work in team in various areas with inclusive effort and sustainability
3	Organize various events and use managerial and budgeting abilities
4	Demonstrate leadership qualities and ethics

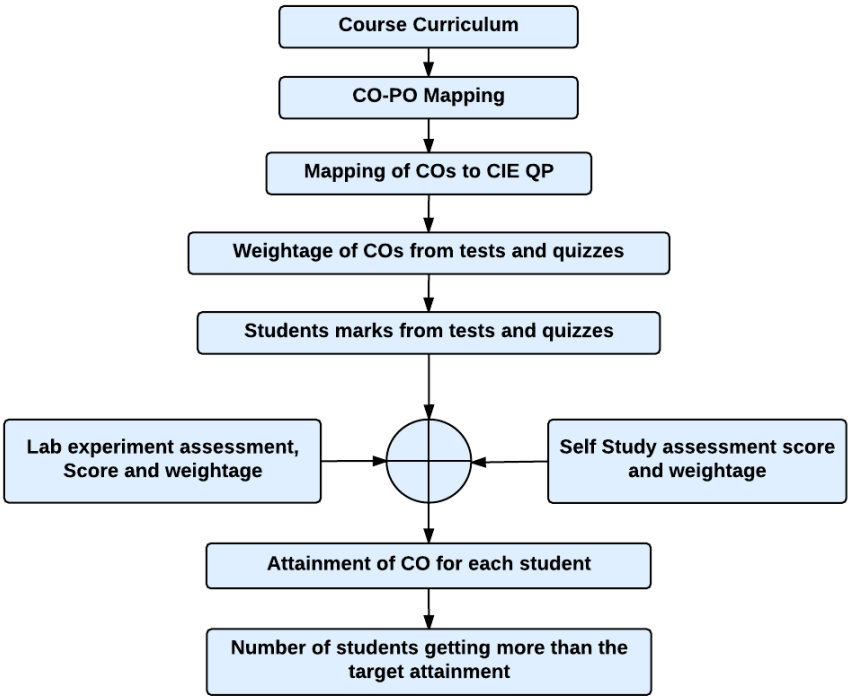
Curriculum Design Process



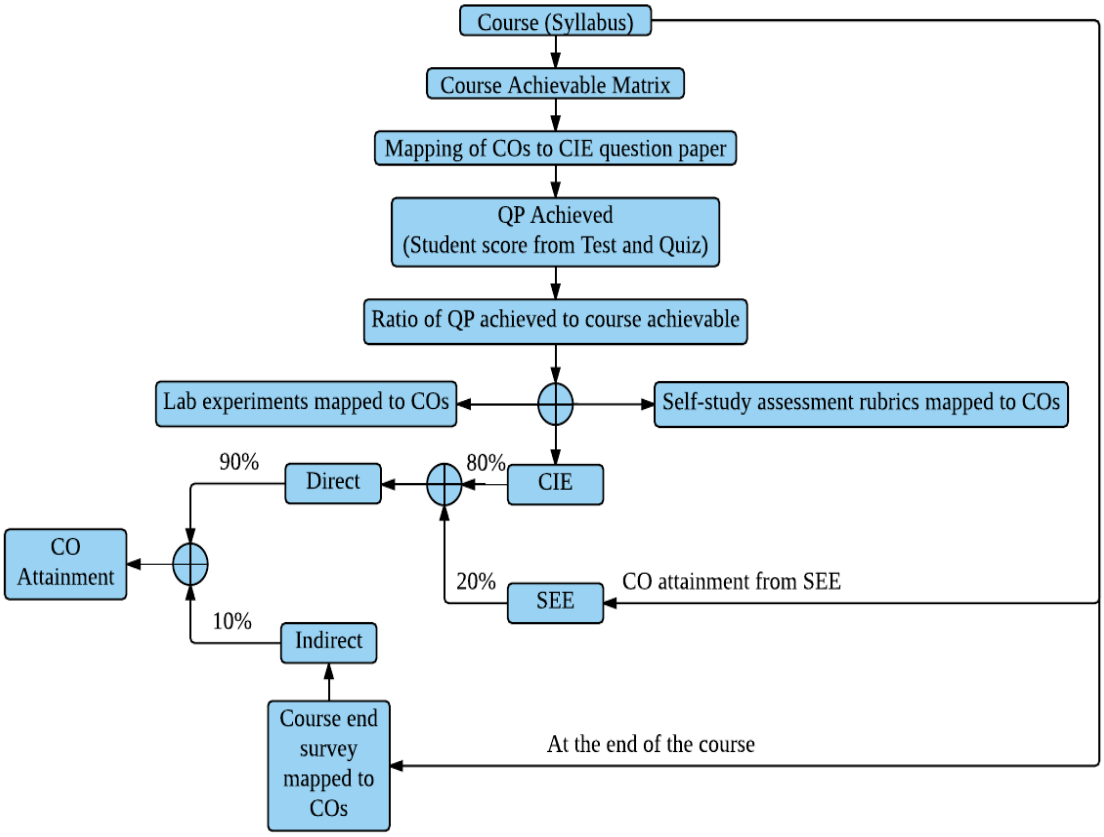
Academic Planning and Implementation



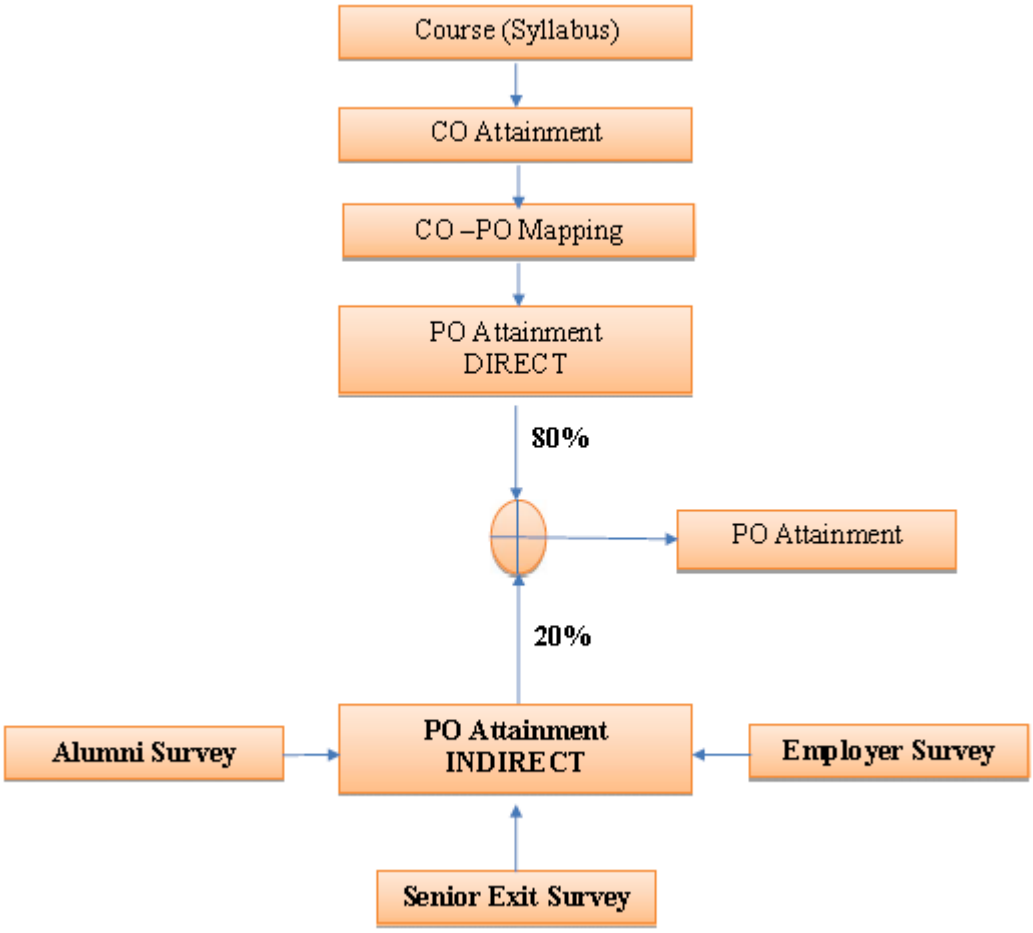
Process for Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



PROGRAM OUTCOMES (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.